6. INSTREAM FLOW STUDIES: FISH, AQUATICS AND RIPARIAN

6.1. Introduction

Project construction and operation would have an effect on the flows downstream of the dam, the degree of which will ultimately depend on final Project design and operating characteristics. The Project would be operated in a load following mode. Project operations would cause seasonal, daily, and hourly changes in Susitna River flows compared to existing conditions. The potential alteration in flows would influence downstream resources/processes, including fish and aquatic biota and their habitats, channel form and function including sediment transport, water quality, groundwater/surface water interactions, ice dynamics and riparian and wildlife communities (AEA 2011).

The potential operational flow induced effects of the Project will need to be carefully evaluated as part of the licensing process. This study plan describes the Susitna-Watana Instream Flow Study (IFS) that will be conducted to characterize and evaluate these effects. The plan includes a statement of objectives, a description of the technical framework that is at the foundation of the IFS, the general methods that will be applied, and the study nexus to the Project. This plan will be subject to revision and refinements as part of the licensing participant review and comment process identified in the ILP. In particular, at this stage in its development, the IFS has not identified specific study sites. These details and others will be developed in consultation with licensing participants as part of the continuing study planning process and during study implementation.

6.2. Nexus between Project Construction / Existence / Operations and Effects on Resources to be Studied

As described above, the operational strategy of the Project could result in a variety of flow responses to the river below Watana Dam. These may include seasonal, daily and hourly changes in river stage that would vary longitudinally along the river. Having a clear understanding of Project effects on instream flow and riparian habitats and biological resources present within the Susitna River corridor will be critical to environmental analysis of the Project.

6.3. Resource Management Goals and Objectives

Several natural resources agencies have jurisdiction over aquatic species and their habitats in the Project area. These agencies will be using in part, the results of the IFS and other fish and aquatic studies to satisfy their respective mandates. The following federal and state agencies and Alaska Native entities have identified their resource management goals, or provided comments in the context of FERC licensing, related to instream flow and riparian resource issues.

6.3.1. National Marine Fisheries Service

The following text is an excerpt of the May 31, 2012 NMFS letter and Instream Flow Study Request:

"NMFS has authority to request water quality and other natural resource studies related to the project pursuant to the: Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), National Environmental Policy Act (NEPA) of 1969 (83 Stat. 852; 42 U.S.C. §4321 et seq.), Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended; 16 U.S.C. §1531 et seq.), Bald and Golden Eagle Protection Act (BGEPA) (54 Stat. 250, as amended, 16 U.S.C. §668a-d), Migratory Bird Treaty Act (MBTA) (40 Stat. 755, as amended; 16 U.S.C. §703 et seq.), Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. §661 et seq.), and Federal Power Act (16 U.S.C. § 91 et seq.).

Under Section 18 of the FPA, NMFS and the USFWS have authority to issue mandatory fishway prescriptions for safe, timely, and effective fish passage. Under Section 10(j) of the FPA, NMFS and USFWS are authorized to recommend license conditions necessary to adequately and equitably protect, mitigate damages to, and enhance, fish and wildlife (including related spawning grounds and habitat) affected by the development, operation, and management of hydropower projects. Section 10(a)(1) of the FPA requires FERC to condition hydropower licenses to best improve or develop a waterway or waterways for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat) based on NMFS and Service recommendations and plans for affected waterways. Therefore, one of the resource management goals of NMFS is to inform development of fishway prescriptions for this project pursuant to Section 18 of the FPA.

A number of Federal regulations address the need to protect and preserve fish and wildlife resources and their habitats, including preventing the "take" of certain species (or groups of species). The following is a list of some of the most important of these regulations which are applicable or may be applicable to the proposed license applications:

- *Federal Power Act*
    - *FERC is required to give equal consideration to "protection, mitigation of damage to, and enhancement of, fish and wildlife (including spawning grounds and habitat)."*
- *Magnuson-Stevens Fishery Conservation Act*
    - *Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established a new requirement to describe and identify EFH in each fishery management plan. The EFH provisions of the MSA (§305(b)) require federal agencies to consult with NMFS on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH*
- *Fish and Wildlife Coordination Act*
    - *Requires equal consideration and coordination of wildlife conservation with other water resources development programs.*

- *National Environmental Policy Act*
    - *Requires evaluation of project alternatives, cumulative effects.*
- *Endangered Species Act*
    - *Section 7(a)(2) requires Federal agencies to ensure that their activities are not likely to jeopardize the continued existence of listed species or adversely modify designated critical habitat.*
- *Anadromous Fish Conservation Act"*

6.3.2. U.S. Fish and Wildlife Service

The following text is an excerpt of the May 31, 2012 USFWS Instream Flow Study Request:

> *"The U.S. Fish and Wildlife Service (USFWS), U.S. Department of Interior, has authority to request fish and wildlife resources studies related to this project pursuant to:*
>
> *The National Environmental Policy Act (NEPA) of 1969 (83 Stat. 852; 42 U.S.C. 4321 et seq.), the Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), the Bald and Golden Eagle Protection Act (BGEPA) (54 Stat. 250, as amended, 16 U.S.C. 668a-d), the Migratory Bird Treaty Act (MBTA) (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), and the Federal Power Act (16 U.S.C. § 791 et seq.).*
>
> *Under Section 18 of the Federal Power Act (FPA), the National Marine Fisheries Service (NMFS), U.S. Department of Commerce and the USFWS have authority to issue mandatory fishway prescriptions for safe, timely, and effective fish passage. Under Section 10(j) of the FPA, NMFS and USFWS are authorized to recommend license conditions necessary to adequately and equitably protect, mitigate damages to, and enhance, fish and wildlife (including related spawning grounds and habitat) affected by the development, operation, and management of hydropower projects. Section 10(a)(1) of the FPA requires FERC to condition hydropower licenses to best improve or develop a waterway or waterways for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat) based on NMFS and USFWS recommendations and plans for affected waterways.*
>
> *Consistent with our mission and with the legal authorities described above, our resource goal in this matter is to conserve existing fish and wildlife resources and their habitats in the Susitna River basin. With regard to fish passage, we will recommend scientifically-based and coordinated studies, collaborate with others, and ensure development of the best information possible to inform potential development of fishway prescriptions for this project pursuant to Section 18 of the Federal Power Act."*

6.3.3. Alaska Department of Fish and Game

The following text is an excerpt of the May 30, 2012 ADF&G letter and Instream Flow Study Request:

> *"The Fish and Game Act requires the Alaska Department of Fish and Game to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020)."*

6.3.4. Alaska Native Entities

6.3.4.1. Chickaloon Village Traditional Council

The Chickaloon Native Village provided comments on Project licensing activities in a May 31, 2012 letter to the FERC. Chickaloon Native Village is a federally recognized Alaska Native tribe. Chickaloon Village is an Ahtna Athabascan Indian Tribe governed by the nine-member Chickaloon Village Traditional Council. The Chickaloon Village Traditional Council strives to increase traditional Ahtna Dene' practices for the betterment of all residents in the area. Preserving and restoring the regions natural resources is one way of supporting Ahtna culture and the regional ecosystem.

6.4. Summary of Consultation with Agencies, Alaska Native Entities, and Other Licensing Participants

Input regarding the issues to be addressed in the IFS has been provided by licensing participants during workgroup meetings commencing in late 2011. During 2012, workgroup meetings were held in January, February, April and June during which resource issues were identified and discussed and objectives of the instream flow studies were defined. Various agencies (USFWS, NMFS, ADF&G, etc.) provided written comments specific to this study which have been considered and will be addressed as part of this plan. Following is a summary of consultations pertaining to instream flow and riparian aspects of the IFS. A summary of communications relevant to the Instream Flow study plans is provided in Table 6.4-1.

Table 6.4-1. Summary of consultation on Instream Flow study plans.

Comment Format	Date	Stakeholder	Affiliation	Subject
Letter	12/30/2011	A.G. Rappoport	USFWS	Critically review 1980s data for applicability to current Project, extend modeling to lower river, monitor flow/sediment in Chulitna and Talkeetna rivers and Gold Creek, quantify fish distributions and collect longitudinal thermal imaging data.
Letter	1/12/2012	P. Bergmann	USDOI	Fully characterize fish habitat use, HSC, species and assemblages throughout all three reaches of the Susitna River and tributaries, address climate change in studies, invasive species, effects of flow changes on fish passage through Devils Canyon. (Filed with FERC.)
Technical Workgroup Meeting Notes	1/24/2012	Various	AEA, USFWS, NMFS, BLM, NPS, ADF&G, ADNR, The Nature Conservancy, Natural Heritage Institute, Alaska Conservation Alliance, Knik Tribe, Chugach Electric Association, Nuvista Light & Power, and other interested parties	Meeting to discuss Project and 2012 study plans. See Attachment 1-1.
Letter	2/10/2012	A.G. Rappoport	USFWS	Use minimum 5-year temporal scale, include winter evaluations beginning in 2012, conduct thermal imaging, use 2-D models, use site-specific data instead of professional judgment for HSC.
E-mail (internal to USFWS)	2/14/2012	W. Rice	USFWS	Suggestion pertaining to installation and operation of streamflow gages on Susitna River.
Letter	2/21/2012	A.G. Rappoport	USFWS	Requested that Adult Salmon Distribution and Habitat Utilization Study be integrated with instream flow and expand spawning habitat study to lower river.
Letter	2/29/2012	J.W. Balsiger	NMFS	Requested information on how interrelated studies will be integrated, requested climate change be incorporated into many, if not all studies. (Filed with FERC.)
Technical Workgroup Meeting Notes	3/02/2012	Various	AEA, USFWS, NMFS, BLM, NPS, ADF&G, ADNR, FERC, Natural Heritage Institute/Hydropower Reform Coalition, Alaska Ratepayers, and other interested parties	Meeting to discuss the 2012 study plans and table of 2013-2014 studies, potential methods and objectives. See Attachment 1-1.

Comment Format	Date	Stakeholder	Affiliation	Subject
E-mail	3/07/2012	J. Klein	ADF&G	Provided information in preparation for an agency teleconference (on 03/07/2012) to discuss instream flow study planning. Requested instream flow study address "patchy" salmon habitat use, winter habitat needs, groundwater influence and HSC curves representative of habitat types, seasons and inter-annual variability.
E-mail	3/07/2012	B. Henszey	USFWS	Bob suggested consideration of the following riparian instream flow needs that might affect migratory bird habitat: •Channel encroachment of riparian veg (appears to be recognized). •Channel degradation lowering the adjacent water table, causing changes in adjacent veg (appears not to be recognized). •Channel aggradation raising the adjacent water table, causing changes in the adjacent veg (not sure this will happen, but should be considered). •Changes in the timing and duration of the hydroperiod (surface and shallow groundwater) on key riparian life stages (e.g., establishment, high flow and ice scour of seedlings, shifting high water levels to later in the season on mature veg).
E-mail	3/07/2012	S. Walker	NMFS	Provided 02/29/2012 comment letter and some suggestions related to instream flow study planning in preparation for an agency teleconference (03/07/2012). Requested careful consideration of constraints of 1980s studies to evaluate proposed Project operations (i.e., winter load following and reduction of summer peak flows). Indicated studies important in middle and lower river.
E-mail	3/07/2012	M. Buntjer	USFWS	Provided 02/10/2012 and 12/20/2011 USFWS letters in preparation for an agency teleconference (on 03/07/2012) to discuss instream flow study planning.
Meeting Notes (Prepared by D. Reiser)	3/07/2012	S. Walker, M. Buntjer, B. McCracken, B. Henszey, J. Klein	NMFS, USFWS, ADF&G	Written summary of teleconference meeting held on 03/07/2012 to discuss 2012 and 2013/2014 studies. Topics included: model flow vs. habitat relationships in all reaches affected by the Project; complete analysis of

Comment Format	Date	Stakeholder	Affiliation	Subject
				fish habitat issues, ice and potential effects of Project on formation, breakup, etc., fish use of winter habitat; groundwater and water temperature and potential Project influences; time series analysis of habitats; and evaluation of riparian communities under alternate Project operations.
Technical Workgroup Meeting Notes	4/04/2012	Various	AEA, USFWS, NMFS, BLM, ADF&G, ADEC, ADNR, Natural heritage Institute/Hydropower Reform Coalition, Coalition for Susitna Dam Alternatives, Alaska Ratepayers, Mike Wood, and other interested parties	Meeting to discuss 2012 study plans and 2013-2014 Study Requests prepared by AEA team. Eric Rothwell (NMFS) requested groundwater / surface water study be developed. See Attachment 1-1.
Technical Workgroup Meeting Notes	4/06/2012	Various	AEA, USFWS, NMFS, BLM, USGS, ADF&G, ADNR, FERC, Natural Heritage Institute/Hydropower Reform Coalition, Alaska Ratepayers, Mike Wood, and other interested parties	Meeting to discuss 2012 study plans and 2013-2014 Study Requests prepared by AEA team. Meeting to discuss 2012 and draft 2013-2014 study plans. See Attachment 1-1.
Phone conversation	5/18/2012	B. Henszey	USFWS	1. Intensive study reach should be located below the Dam site to assess channel issues relative to channel degradation due to lack of sediment transport. 2. Would like to see enough well transects at our intensive study reaches to capture all the riparian plant community types found in the Susitna River floodplain. 3. Groundwater root zone interactions need to be measured and modeled in the groundwater/surface water study.
Phone conversation	5/22/2012	J. Mouw	ADF&G	1. Balsam poplar phenology, seed release period he has observed on the Susitna River (seed release generally in the window of June 20-July 4th), 2. Dendrochronological studies he is conducting on the Talkeetna River floodplain, 3. Types of historic river gauge data, and 4. General ecology of riparian forest succession he has observed. 5. Role of beaver in floodplain wetland and off-channel

Comment Format	Date	Stakeholder	Affiliation	Subject
				water body formation.
Phone conversation	5/25/2012	B. Henszey	USFWS	Discussed proposed riparian vegetation sampling design
Study Requests and Letters	5/30/2012 - 5/31/2012	Various	Multiple Stakeholders	Stakeholders' comments on PAD, SD1 and study requests. (Filed with FERC).
E-mails (several)	6/07/2012	J. Klein, M. Buntjer, B. Henszey, S. Walker	NMFS, USFWS, ADF&G	Reponses to request for follow-up post-licensing participant meeting to be held in the afternoon of 06/13/2012.
Technical Workgroup Meeting Notes	6/13/2012	Various	AEA, USFWS, NMFS, ADF&G, ADEC, ADNR, BLM, EPA, USGS, FERC, Natural Heritage Institute/Hydropower Reform Coalition, Alaska Ratepayers, Coalition for Susitna Dam Alternatives and other interested parties	Meeting to discuss Stakeholder Study Requests. See Attachment 1-1.
Meeting Notes	6/13/2012	J. Klein, M. Buntjer, B. McCracken, S. Walker (via teleconference), B. Henszey	ADF&G,USFWS,NMFS	Meeting to discuss planning for September agency field reconnaissance trip to review instream flow study methods and models and to identify candidate study sites.
Technical Workgroup Meeting Notes	6/14/2012	Various	AEA, USFWS, BLM, NMFS, Coalition for Susitna River Dam Alternatives, EPA, ADF&G, ADNR, NPS, USGS, Natural Heritage Institute/Hydropower Reform Coalition, FERC, and other interested parties	See Attachment 1-1. Sue Walker (NMFS) requested: 1. An analysis of climate change effects on evapotranspiration rates of trees and how this may affect tree growth rates. 2. Analysis of how operational flows may affect potential for exotic plant species invasion of natural floodplain plant communities.

6.5. Fish and Aquatics Instream Flow Study

6.5.1. General Description of the Proposed Study

6.5.1.1. Focus of IFS

The 2013-2014 IFS plan is specifically directed toward establishing an understanding of important biological communities and associated habitats, and the hydrologic, physical, and chemical processes in the Susitna River that directly influence those resources. The focus of much of this work will be on establishing a set of analytical tools/models based on the best available information and data that can be used for defining both existing or base conditions; i.e., without Project, and how these resources and processes will respond to alternate Project operations.

6.5.1.2. Study Goals and Objectives

The objective of the IFS and its component study efforts is to provide quantitative indices of existing aquatic habitats and the effects of alternate Project operational scenarios. Specific objectives of the study include the following:

1. Map the current aquatic habitat in mainstem and lateral habitats of the Susitna River affected by Project operations.
2. Select study sites and sampling procedures to measure and model mainstem and lateral Susitna River habitat types.
3. Develop a hydraulic routing model that estimates water surface elevations and average water velocity along modeled transects on an hourly basis under alternate operational scenarios.
4. Develop seasonal, site-specific Habitat Suitability Curves (HSC) and Habitat Suitability Indices (HSI) for species and lifestages of fish selected in consultation with licensing participants. Criteria will include observed physical phenomena that may be a factor in fish preference (e.g., depth, velocity, substrate, embeddedness, proximity to cover, groundwater influence, turbidity, etc.). If study efforts are unable to develop robust site-specific data, HSC/HSI will be developed using the best available information and selected in consultation with licensing participants.
5. Develop integrated aquatic habitat models that produce a time series of data for a variety of biological metrics under existing conditions and alternate operational scenarios. These metrics include (but are not limited to):
    - water surface elevation at selected river locations;
    - water velocity within study site subdivisions (cells or transects) over a range of flows during seasonal conditions;
    - varial zone area;
    - frequency and duration of exposure/inundation of the varial zone at selected river locations; and
    - habitat suitability indices.

6. Evaluate existing conditions and alternate operational scenarios using a hydrologic database that includes specific years or portions of annual hydrographs for wet, average and dry hydrologic conditions and warm and cold Pacific Decadal Oscillation (PDO) phases.
7. Coordinate instream flow modeling and evaluation procedures with complementary study efforts including riparian (Section 6.6), geomorphology (Section 5.8 and 5.9), groundwater (Section 5.7), water quality (Section 5.5), fish passage (Section 7.12), and ice processes (Section 5.10). If channel conditions are expected to change over the license period, instream flow habitat modeling efforts will incorporate changes identified and quantified by riverine process studies.
8. Conduct a variety of post-processing comparative analyses derived from the output metrics estimated under aquatic habitat models. These include (but are not limited to):
   - juvenile and adult rearing;
   - adult holding;
   - habitat connectivity;
   - spawning and egg incubation;
   - juvenile fish stranding and trapping;
   - ramping rates; and
   - distribution and abundance of benthic macroinvertebrates.

6.5.2. Existing Information and Need for Additional Information

6.5.2.1. Summary of Existing Information

Substantial physical, hydrologic and biological information is available for the Susitna River as a result of previous hydropower licensing efforts conducted during the 1980s. The extent and details of many of those studies were provided in the Draft Environmental Impact Statement (DEIS 1984) for the previous proposed project (FERC No. 7114) along with companion appendices and attachments in the way of ADF&G reports. A gap analysis report conducted by HDR (2011) summarized some of the data. The gap analysis provided an initial listing of salient reports and data that warrant more detailed evaluations.

The 1980s project was envisioned as a two-dam project, with an upper dam, reservoir and powerhouse near RM 184 (Watana Dam). The upper development would be operated in load-following mode to meet power demands. A lower dam, reservoir and powerhouse (Devils Canyon Dam) would provide additional power generation, but would also reregulate flow releases from the upper development. Downstream flow releases from the Devils Canyon Dam would not have the daily flow fluctuations associated with load-following operations of the upper development. In addition, since the Devils Canyon Dam would create a reservoir that would inundate much of the river between the two dams, the instream flow and riparian study efforts in the 1980s focused on the effects of flow releases Susitna River downstream of the Devils Canyon Dam site and the reach between the Devils Canyon Dam and Watana Dam sites were not modeled as part of the instream flow study. These are important differences between the current proposal and that of the 1980s. The Project, as currently proposed, without the re-regulation of flows that a second dam would allow, will require the evaluation of downstream effects of load-following operations on fish and wildlife resources downstream of the Watana Dam site.

Inspection of the 1980s reports confirms that the majority of efforts were focused on the middle and lower river reaches of the Susitna River. As part of the review effort, over sixty reports from the 1980s and earlier were identified as useful for compilation or synthesis of existing information. The identified documents included 83 separate volumes containing descriptions of field studies and reports with tabular data, figures, and maps. A listing of the studies for which reports have been reviewed includes:

- Water quality investigations
- Adult salmon passage in sloughs and side channels
- Adult salmon spawn timing and distribution
- Channel geometry investigations
- Groundwater upwelling detection
- Hydrological investigations and modeling of anadromous and resident fish habitat
- Juvenile salmon abundance and distribution
- Resident fish abundance, distribution and life history
- Salmon habitat suitability criteria
- Salmon spawning habitat evaluation

Synthesis of pertinent information will be completed as part of the IFS and supplemented by analysis of aquatic-related information conducted as part of the Fish and Aquatic Program (Section 7). As part of this synthesis, information will be compiled and reviewed related to instream flow regimes implemented at other large hydropower projects, with a special emphasis on projects developed in arctic and sub-arctic environments.

6.5.2.2. Need for Additional Information

The gap analysis presented in HDR (2011) outlines the major elements required in an instream flow study. Although substantial data and information were collected in the 1980s, those data are approximately 30 years old and therefore additional information needs to be collected to provide a contemporary understanding of the baseline conditions existing in the Susitna River. In addition, the configuration and proposed operations of the Project are different from the previously proposed project and must be evaluated within the context of the existing environmental setting. This includes consideration of potential load following effects on important aquatic and riparian habitats downstream of the proposed Watana Dam site (including both the middle and lower river, as appropriate). Potential effects of proposed Project operations on aquatic habitats and biota and potential benefits and impacts of alternative operational scenarios have not been quantitatively analyzed. The aquatic habitat specific models will provide an integrated assessment of the effects of Project operations on biological resources and riverine processes. These models will provide an analytical framework for assessing alternative operational scenarios and quantitative metrics that will provide the basis for the environmental assessment and aid in comparing alternatives that may lead to refinements in proposed Project operations.

6.5.3. Study Area

During the 1980s studies, the Susitna River was characterized into three reaches corresponding to an upper river reach representing that portion of the watershed above the Watana Dam site at RM 184; a middle river reach (extending from RM 184 downstream through Devil Canyon to the confluence of the three rivers at RM 98.5) and a lower river reach (extending from the confluence of Chulitna and Talkeetna rivers (three rivers) to Cook Inlet (RM 0). Potential Project effects to the upper river reach above the Watana Dam site are addressed in Section 7: Fish and Aquatics, Section 8: Wildlife, Section 9: Botanical, and other studies; however, Project effects to the upper river reach will not be addressed in the instream flow study.

The "middle river" encompasses the approximate 85-mile reach between the proposed Watana Dam site and the three rivers confluence, located at RM 98.5. The river flows from Watana Canyon into Devil Canyon, the narrowest and steepest gradient reach on the Susitna River. In Devil Canyon, constriction creates extreme hydraulic conditions including deep plunge pools, drops, and high velocities. The Devil Canyon rapids form a partial barrier to the migration of anadromous fish; only a few adult Chinook salmon have been observed upstream of Devil Canyon. Downstream of Devil Canyon, the middle Susitna River widens but remains essentially a single channel with stable islands, occasional side channels, and sloughs. For purposes of this study plan, the middle reach has been further divided into three segments corresponding to Above Devils Canyon, Within Devils Canyon, and Below Devils Canyon.

The "lower river" describes the approximate 98-mile reach between the Chulitna River confluence and Cook Inlet (RM 0). An abrupt change in channel form occurs where the Chulitna River joins the Susitna River near the town of Talkeetna. The Chulitna River drains a smaller area than the Middle Susitna River Reach at the confluence, but drains higher elevations (including Denali and Mount Foraker) and many more glaciers. The annual flow of the Chulitna River is approximately the same as the Susitna River at the confluence, though the Chulitna contributes much more sediment than the Susitna. For several miles downstream of the confluence, the Susitna River becomes braided, characterized by unstable, shifting gravel bars and shallow subchannels. For the remainder of its course to Cook Inlet, the Susitna River alternates between single channel, braided, and meandering planforms with multiple side channels and sloughs. Major tributaries drain the western Talkeetna Mountains (the Talkeetna River, Montana Creek, Willow Creek, Kashwitna River), the Susitna lowlands (Deshka River), and the Alaska Range (Yentna River). The Yentna River is the largest tributary in the Lower River Reach, supplying about 40 percent of the mean annual flow at the mouth.

The instream flow study area includes mainstem and lateral habitats of the Susitna River downstream of the proposed Watana Dam site at RM 184. For purposes of this study, the instream flow study area has been divided into the following river reaches and segments (Figure 6.5-1):

- Middle River Reach – Susitna River from Watana Dam site to confluence of Chulitna and Talkeetna rivers (three rivers) (RM 184 to RM 98.5). This reach is further divided into three segments including:
    - Upper Segment – Watana Dam site to upstream end of Devils Canyon.
    - Middle Segment – upstream end of Devils Canyon to downstream end of Devils Canyon.

    - Lower Segment – downstream end of Devils Canyon to Three Rivers (RM 98.5).
- Lower River Reach — Susitna River extending below Talkeetna River to mouth (RM 98.5 to RM 0)

Further refinement of these reach designations may occur as part of the Stratification task under the 2012 geomorphology study plans and in consultation with the licensing participants.

6.5.4. Study Methods

Evaluation of potential Project effects to middle and lower river habitats will consist of the following components (these components will be refined based on licensing participant review):

- Analytical Framework;
- Habitat Mapping (See also sections 5.8and 7.9);
- Hydraulic Routing and Hydrologic Data Analysis;
- Habitat Suitability Criteria (HSC) or Habitat Suitability Indices (HSI) development for fish and benthic macroinvertebrates; and
- Habitat-Specific Models Development, including varial zone modeling and fish passage/off-channel fish connectivity.

6.5.4.1. IFS Analytical Framework

Figure 6.5-3 depicts the analytical framework of the IFS commencing with the Reservoir Operations Model (ROM) that will be used to generate alternate operational scenarios under different hydrological conditions. The overall framework includes analytical steps that are consistent with those described in the Instream Flow Incremental Methodology (IFIM) (Stalnaker et al. 1996), which will be used as a guide for completing the instream flow evaluation for the Project. The ROM will provide the input data to the mainstem flow routing model that will be used to predict hourly flow and water surface elevation data at multiple points downstream, taking into account accretion and flow attenuation. Coincident with the development of the flow routing model, a series of biological and riverine process studies will be completed (other studies) to supplement the information collected in the 1980s as necessary to define reliable relationships between mainstem flow and riverine processes and biological resources. This will result in development of a series of flow sensitive models (e.g., models of selected anadromous and resident fish habitats by species and life stage, models to assess connectivity and passage conditions provided into side channel and slough habitats, models to describe invertebrate habitats, temperature model, ice model, sediment transport model, turbidity model, large woody debris (LWD) recruitment model) that will be able to translate effects of alternative Project operations on the respective processes and biological resources.

As part of the Analytical Framework, an Instream Flow Study-Technical Work Group (IFS-TWG) will be formed consisting of technical representatives from agency and licensing participant groups. The IFS-TWG will provide input into specific study design elements pertaining to the IFS including selection of study sites, selection of methods and models, selection of HSC criteria, review and evaluation of hydrology and habitat-flow modeling results, and review of Project operations/habitat modeling results. The IFS-TWG will meet independently of the larger licensing participant group.

Resource and process effects will be location and habitat specific (e.g., responses are expected to be different in side sloughs versus mainstem versus side channel versus tributary delta versus riparian habitats) but there will also be a cumulative effect that translates throughout the entire length of the Susitna River. Alternate Project operational scenarios will likely affect different habitats and processes differently, both spatially and temporally. The habitat and process models will therefore be spatially discrete (e.g., by site, segment, and reach) and yet able to be integrated to allow for a holistic evaluation of each alternative operational scenario. This will allow for an Integrated Resource Analysis of separate operational scenarios that includes each resource element, the results of which can serve in a feedback capacity leading to new or modifications of existing operations scenarios.

The IFS plan is focused on development of macro-habitat specific models that can reliably estimate flow-habitat response patterns for different species and life stages of fish and other aquatic biota. This will include a mainstem aquatic habitat model, side channel models, one or more side slough models (may vary by flow activation level), a tributary mouth and delta model; and a riparian model. These models represent the core tools that will be used for assessing changes in aquatic habitats under alternative Project operational scenarios. The conceptual framework for these tools is depicted in Figure 6.5-3. A study focused on groundwater related aquatic habitat will be also be developed that may incorporate one or more of these models to assess linkages between surface flows and groundwater flows that comprise important fish habitats. Additionally, a fish passage model (Section 7.12) will also be used to develop the relationship between main channel flow and connectivity with side channel and off-channel areas. Data collection and modeling for the fish passage study will be coordinated with the instream flow, fisheries, and geomorphology studies (Section 5.9 and 5.10) to ensure identification of potential fish passage barriers and hydraulic control points.

6.5.4.2. Habitat Mapping

During the 1980s studies, the riverine related habitats of the Susitna River were divided into six macro-habitat categories consisting of mainstem, side channel, side slough, upland slough, tributaries, and tributary mouths (ADF&G 1984). The distribution and frequency of these habitats varies longitudinally within the river depending in large part on its confinement by adjoining floodplain areas, size, and gradient. These habitat feature types are depicted in Figure 6.5-2 which was adopted from ADF&G (1983) and Trihey (1982); the habitat types were described with respect to mainstem flow influence by ADF&G in the Susitna Hydroelectric Aquatic Studies Procedures Manual (1984) as follows:

- **Mainstem Habitat** consists of those portions of the Susitna River that normally convey streamflow throughout the year. Both single and multiple channel reaches are included in this habitat category. Groundwater and tributary inflow appear to be inconsequential contributors to the overall characteristics of mainstem habitat. Mainstem habitat is typically characterized by high water velocities and well armored streambeds. Substrates generally consist of boulder and cobble size materials with interstitial spaces filled with a grout-like mixture of small gravels and glacial sands. Suspended sediment concentrations and turbidity are high during summer due to the influence of glacial melt-water. Streamflows recede in early fall and the mainstem clears appreciably in October. An ice cover forms on the river in late November or December.

- **Side Channel Habitat** consists of those portions of the Susitna River that normally convey streamflow during the open water season but become appreciably dewatered during periods of low flow. Side channel habitat may exist either in well-defined overflow channels, or in poorly defined water courses flowing through partially submerged gravel bars and islands along the margins of the mainstem river. Side channel streambed elevations are typically lower than the mean monthly water surface elevations of the mainstem Susitna River observed during June, July and August. Side channel habitats are characterized by shallower depths, lower velocities and smaller streambed materials than the adjacent habitat of the mainstem river.
- **Side Slough Habitat** is located in spring fed overflow channels between the edge of the floodplain and the mainstem and side channels of the Susitna River and is usually separated from the mainstem and side channels by well vegetated bars. An exposed alluvial berm often separates the head of the slough from mainstem or side channel flows. The controlling streambed/streambank elevations at the upstream end of the side sloughs are slightly less than the water surface elevations of the mean monthly flows of the mainstem Susitna River observed for June, July, and August. At intermediate and low-flow periods, the side sloughs convey clear water from small tributaries and/or upwelling groundwater (ADF&G 1981c, 1982b). These clear water inflows are essential contributors to the existence of this habitat type. The water surface elevation of the Susitna River generally causes a backwater to extend well up into the slough from its lower end (ADF&G 1981c, 1982b). Even though this substantial backwater exists, the sloughs function hydraulically very much like small stream systems and several hundred feet of the slough channel often conveys water independent of mainstem backwater effects. At high flows the water surface elevation of the mainstem river is sufficient to overtop the upper end of the slough (ADF&G 1981c, 1982b). Surface water temperatures in the side sloughs during summer months are principally a function of air temperature, solar radiation, and the temperature of the local runoff.
- **Upland Slough Habitat** differs from the side slough habitat in that the upstream end of the slough is not interconnected with the surface waters of the mainstem Susitna River or its side channels. These sloughs are characterized by the presence of beaver dams and an accumulation of silt covering the substrate resulting from the absence of mainstem scouring flows.
- **Tributary Habitat** consists of the full complement of hydraulic and morphologic conditions that occur in the tributaries. Their seasonal streamflow, sediment, and thermal regimes reflect the integration of the hydrology, geology, and climate of the tributary drainage. The physical attributes of tributary habitat are not dependent on mainstem conditions.
- **Tributary Mouth Habitat** extends from the uppermost point in the tributary influenced by mainstem Susitna River or slough backwater effects to the downstream extent of the tributary plume which extends into the mainstem Susitna River or slough (ADF&G 1981c, 1982b).

The studies completed in the 1980s demonstrated that these habitat types are utilized to varying degrees and at different times by different species and life stages, with some species seeming to prefer certain habitat types over others (Dugan et al. 1984). Importantly, there will likely be both inter- and intra-habitat: flow response differences between and among these habitat types, and each will require separate investigation. Fortunately, many of the studies conducted in the 1980s were directed toward understanding those relationships (e.g., Marshall et al. 1984) and thus, there is already an existing pool of information and data that will be useful in the development of the 2013-2014 studies. The IFS will utilize these same designations, with some refinements or additions if necessary in consultation with the licensing participants to provide further clarity of habitat types.

The aquatic habitat specific models will be used to evaluate the effects of alternate Project operational scenarios on aquatic habitats in the Susitna River. One of the initial model development tasks will be the selection of detailed study sites and establishment of transects. These study sites and transects will be representative of habitat conditions based on channel morphology and major habitat features (See also Section 5.8 and 7.9). Study sites, transects and 2-D model mesh density will also be selected, as appropriate, to describe distinct habitat features that are important to aquatic biota (e.g., known areas of groundwater influence; spawning habitats, rearing habitats, etc.). In order to select these study sites and transects, specific information on both channel morphology and other important habitat features within the Susitna River will be needed. This information will allow AEA and licensing participants to decide on the final number and placement of study sites and data collection methods to best represent the system within the modeling platform.

The Habitat Mapping study component provides the critical information needed about the distribution of major and distinct habitat features in the study area to select these areas for the aquatic habitat specific models.

6.5.4.2.1. Proposed Methodology

The distribution and proportion of major habitat types in the Susitna River will be identified using analyses of bathymetric data, aerial photography, site-specific habitat and biological surveys (e.g., 1980s studies), and licensing participant knowledge of the Project area This effort will be coordinated with other riverine process and fish studies (See Sections 5.8-Geomorphology Study, 5.9 - Fluvial Geomorphology Study, and various fish studies designed to characterize the distribution, abundance and habitat characteristics of fish populations in the lower, middle and upper Susitna River (Sections 7.5, 7.6, 7.7, and 7.9). The location and distribution of distinct habitat types, areas of intense fish spawning activity/rearing will also be identified using available information and the results of site-specific surveys (See Section 7.6 – Fish Distribution and Abundance in the Middle and Lower Susitna River) and 7.9 – Characterization of Aquatic Habitats in the Susitna River with Potential to be Affected by the Susitna – Watana Hydroelectric Project). The specific tasks likely to be involved in this study component include the following (subject to revision and refinement following licensing participant review):

- Channel Typing – Use bathymetric data and aerial mapping techniques to determine the proportion of major channel types by reach and for the total Project area (Section 5.9).
- Wetted Width Calculations – Use Geographical Information System (GIS) analysis to calculate wetted widths of channel at selected locations representing different habitat types, under different flow conditions (this study).

- Wetted Surface Area Calculations – Use GIS analysis to calculate by reach the total wetted surface area of the Susitna River channel under different flow conditions (this study).
- Aquatic Habitat Mapping – Using aerial photography, and aerial videography, map existing main channels, side channels, side sloughs, upland sloughs, tributary mouths and other salient habitat features that are aligned with the Susitna River under different flow conditions. This work will rely on the analysis being completed by the 2012 Geomorphology studies. Mapping efforts will also incorporate areas of groundwater influence identified by groundwater studies (See Section 5.7), and any aquatic areas of particular importance identified as part of the water quality (See Section 5.5) and fish and aquatic biological studies (See Section 7).
- Interviews –Interview licensing participants, local biologists, anglers, guides and other personnel familiar with the Project area and identify areas supporting fish spawning/rearing and other areas of concentrated biological activity.
- Data Compilation – Compile information on channel type, width, depth, surface area, aquatic habitat types, and concentrated biological activity to determine the location and distribution of representative and distinct habitats.

6.5.4.2.2. Work Products

The Habitat Mapping study component will include the following work products:

- Map and tabular summary of channel types
- Map and tabular summary of macrohabitat types
- Map and tabular summary of areas of known groundwater influence and other areas of special ecological importance
- Tabular summary of wetted width and wetted surface area calculations
- Documentation of interviews

These work products and other results of the aquatic habitat mapping study will be compiled and presented in a draft and final study report. This work will rely in part on the analysis being completed by 2012 Geomorphology studies (Section 5.8), Groundwater studies (Section 5.7), and Characterization of Aquatic Habitats (Section 7.9).

6.5.4.3. Hydraulic Routing and Hydrologic Data Analysis

Project operations will likely store water during the snowmelt season (May through August), and release it during the winter (October through April) (AEA 2011). This would alter the seasonal hydrology in the Susitna River downstream from the dam (lower flows from May through August and higher flows from October through April). In addition to these seasonal changes, the Project may be operated in a load-following mode. Daily load-following operations will typically release higher volumes of water during peak-load hours, and lower volumes of water during off-peak hours. Flow fluctuations that originate at the powerhouse will travel downstream and attenuate, or dampen, as they travel downstream. The waves created by load-following operations impact the aquatic habitat of the Susitna River downstream from the powerhouse, especially along the margins of the river that are alternately wetted and dewatered (the varial zone). Assessment of potential Project-related impacts on downstream habitats will rely on information provided by the instream flow study (surface water flow routing during ice-free conditions), the geomorphology study (sediment supply/transport regime and channel morphology; Sections 5.8 and 5.9), ice processes study (surface water flow routing during the winter, ice growth and break up)(See Section 5.10), groundwater study (surface water/groundwater interactions)(See Section 5.7), and riparian instream flow botanical surveys (See Section 6.6).

6.5.4.3.1. Proposed Methodology

To analyze the impacts of alternate Project operational scenarios on habitats downstream of the Watana Dam site, a hydraulic routing model will be used to translate the effects of changes in flow associated with Project operations to downstream Susitna River locations; the hydraulic routing model will be extended downstream until the flow fluctuations are within the range of without-Project conditions.

Steady-state flow models assume that the change in velocity or flow at a given location is fairly uniform. Unsteady flow models are used when flows change rapidly and the consideration of time is an additional variable. One-dimensional unsteady flow hydraulic models are commonly used to route flow and stage fluctuations through rivers and reservoirs. Examples of public-domain computer models used to perform these types of processes include FEQ (USGS 1997), FLDWAV (U.S. National Weather Service 1998), UNET (U.S. Army Corps of Engineers 2001), and HEC-RAS (U.S. Army Corps of Engineers 2010a, 2010b, and 2010c). The HEC-RAS model has proven to be very robust under mixed flow conditions (subcritical and supercritical), as will be expected in the Susitna River. The HEC-RAS model also has the capability of automatically varying Manning's "n" with stage through the use of the equivalent roughness option. Another feature of HEC-RAS is the capability of varying Manning's "n" on a seasonal basis. The robust performance and flexibility of HEC-RAS make this model an appropriate choice for routing stage fluctuations downstream from the proposed Project dam under summer ice-free conditions. Under winter ice-covered conditions, the CRISSP1D (Comprehensive River Ice Simulation System Project) model can be used to route unsteady flows downstream through the Susitna River. CRISSP1D is a one-dimensional unsteady flow model that can be used to analyze water temperature, thermal ice transport processes, and ice cover breakup (Chen et al 2006). The seasonal timing of the transition from the HEC-RAS model to the CRISSP1D model and vice versa will vary from year-to-year and will depend on meteorological conditions.

The foundation of the IFS analyses rests with the development of the Susitna River Mainstem Flow Routing Models (HEC-RAS, CRISSP1D and/or other routing models) (MFRM) that will provide hourly flow and water surface elevation data at numerous locations longitudinally distributed throughout the length of the river extending from RM 184 downstream to RM 75 (about 23 miles downstream from the confluence with the Chulitna River). Two different flow routing models will be developed: a summer ice-free model (HEC-RAS); and a winter model to route flows under ice-covered conditions (CRISSP1D or equivalent).

The routing models will initially be developed based on approximately 100 transects and on gaging stations at approximately nine locations on the Susitna River that will be established and measured in 2012 as part of the IFS program. The hourly flow records from USGS gaging stations on the Susitna River will also be utilized to help develop the routing models. Depending on the initial results of the flow routing models, it may be necessary to add additional transects to improve the performance of the models between RM 75 and RM 184, and to possibly extend the models further downstream past RM 75.

During the development and calibration of the HEC-RAS model, the drainage areas of ungraged tributaries will be quantified and used to help estimate accretion flows to the Susitna River between locations where flows are measured. The flow estimates developed for ungaged tributaries will be refined based on flows measured in those tributaries in 2013 and 2014.

The gaging stations initially installed in 2012 will be maintained through 2013 and 2014 to help calibrate and validate the flow routing models and provide data supporting other studies. The gaging stations will be used to monitor stage and flow under summer ice-free conditions and to monitor water pressure under winter ice-covered conditions. Continuous measurement of water pressures during the 2012/2013 and the 2013/14 winter periods under ice-covered conditions will produce information different from open-water conditions. During partial ice cover, the pressure levels measured by the pressure transducers is affected by flow velocities, ice-cover roughness characteristics and other factors such as entrained ice in the water column. The pressure-head data are important for understanding groundwater/surface-water interactions.

Periodic winter discharge measurements will be completed at selected gaging stations in the winter, in coordination with USGS winter measurement programs, and will provide valuable information for understanding hydraulic conditions in the river during a season when groundwater plays a more prominent role in aquatic habitat functions. Winter flow measurements will also be used to help develop the CRISSP1D model (or equivalent).

Output from the flow routing models will provide the fundamental input data to a suite of habitat specific and riverine process specific models that will be used to describe how the existing flow regime relates to and has influenced various resource elements (e.g., salmonid spawning and rearing habitats and the accessibility to these habitats in the mainstem, side channels, sloughs, and tributary deltas, invertebrate habitat, sediment transport processes, ice dynamics, large woody debris (LWD), the health and composition of the riparian zone). These same models will likewise be used to evaluate resource responses to alternative Project operational scenarios, again via output from the routing models, including various baseload and load following alternatives, as appropriate. As an unsteady flow model, the routing models will be capable of providing flow and water surface elevation information at each location on an hourly basis and therefore Project effects on flow can be evaluated on multiple time steps (hourly, daily, and monthly) as necessary to evaluate different resource elements.

The study objective for the flow routing data collection effort is to provide input, calibration, and verification data for a river flow routing model extending from the proposed dam site to RM 75. Specific objectives are as follows:

- Survey cross sections to define channel topography and hydraulic controls between RM 75 and RM 184, excluding Devils Canyon (for safety reasons);
- Measure stage and discharge at each cross section during high and low flows, with the potential addition of an intermediate flow measurement;
- Measure the water surface slope during discharge measurements, and document the substrate type, groundcover, habitat type, and woody debris in the flood-prone area for the purposes of developing roughness estimates; and

- Install and operate approximately 8 to 10 water-level recording stations in collaboration with other studies.

The routing model will rely upon existing Susitna River hydrology as well as output from the ROM.

The assessment of hydrology data will include a summary of seasonal and long-term hydrologic characteristics for the river including daily, monthly and annual summaries, exceedance summaries and recurrence intervals of small and large floods. The analysis will utilize the Indicators of Hydrologic Alteration (IHA) and Range of Variability models developed by the Nature Conservancy (TNC 2005) for computing baseline hydrologic characteristics. The IHA/ROV models are components of an analytical software package typically used to characterize and compare complex river reach or river basin-scale hydrologic regimes from two or more periods of time, such as pre-dam and post-dam (The Nature Conservancy 2005).

The traditional approach developed by The Nature Conservancy utilizes average daily flows to compute a set of 33 parameters that may be categorized in 5 general groups of statistics:

- Magnitude of annual extremes (1-, 3-, 7-, 30- and 90-day maximum and minimum flows)
- Timing of annual extremes (Julian date of 1-day maximum and minimum)
- Magnitude of monthly conditions (variability of monthly means over analysis period)
- Frequency and duration of high and low flow pulses (defined by annual exceedance flows)
- Rate and frequency of changes in daily flows

In addition to the analyses using daily flow records, modifications to the analysis package will be considered in consultation with licensing participants to utilize hourly data to evaluate the rate of change and range of daily flows:

- Minimum, maximum and mean daily flow hydrograph;
- Hourly rate of change for various event types (ramping; diurnal meltwater fluctuations; storm events);
- Annual or seasonal frequency of change rates; and
- Reservoir pool levels (annual and monthly extremes; daily stage change).

6.5.4.3.2. Work Products

The Hydraulic Routing and Hydrologic Data Analysis study component will include the following work products:

- Executable model of the Susitna River to route unsteady flows from the Watana Dam site downstream to the river reach where the influence of Project operations is dampened to within the range of natural stage fluctuations.
- Tabular summaries of selected IHA-type statistics.
- Summary charts to provide visual comparisons of selected hydrologic statistics to facilitate discussion of the effect of modeled future operational scenarios on the without-Project hydrologic regime.

These work products and other results of the hydraulic routing and hydrologic data analyses will be compiled and presented in a study report.

6.5.4.4. Habitat Suitability Criteria Development

Habitat suitability criteria and index curves have been utilized by natural resources scientists for over two decades to assess the effects of habitat changes on biota. The abbreviation HSI is used in this document to refer to either Habitat Suitability Index (HSI) models or Habitat Suitability Criteria (HSC) curves, depending on the context. HSI models provide a quantitative relationship between numerous environmental variables and habitat suitability. An HSI model describes how well each habitat variable individually and collectively meets the habitat requirements of the target species and lifestage, under the structure of Habitat Evaluation Procedures (USFWS 1980). Alternatively, HSC are designed for use in the Instream Flow Incremental Methodology to quantify changes in habitat under various flow regimes (Bovee et al. 1998). HSC describes the instream suitability of habitat variables related only to stream hydraulics and channel structure. Both HSC and HSI models are scaled to produce an index between 0 (unsuitable habitat) and 1 (optimal habitat). Both models and habitat index curves are hypotheses of species-habitat relationships and are intended to provide indicators of habitat change, not to directly quantify or predict the abundance of target organisms. For the Susitna-Watana Hydroelectric Project aquatic habitat studies, HSC (i.e., depth, velocity and substrate/cover) and HSI (i.e., turbidity, duration of inundation and dewatering) models will be integrated to analyze the effects of alternate operational scenarios.

HSC/HSI curves represent an assumed functional relationship between an independent variable, such as depth, velocity, substrate, groundwater, turbidity, etc., and the response of a species life stage to a gradient of the independent variable (suitability). In traditional instream flow studies, HSC curves for depth, velocity, substrate and/or cover are combined in a multiplicative fashion to rate the suitability of discrete areas of a stream for use by a species and life stage of interest. HSC curves translate hydraulic and channel characteristics into measures of overall habitat suitability in the form of weighted usable area (WUA). Depending on the extent of data available, HSC curves can be developed from the literature, or from physical and hydraulic measurements made in the field in areas used by the species and life stages of interest (Bovee 1986). HSC curves for the Susitna-Watana Hydroelectric Project will be based on information consisting of (in order of preference): 1) new site specific data collected for selected target species and life stages (seasonally if possible (e.g., winter)); 2) existing site specific data collected from the Susitna River during the 1980s studies; 3) site specific data collected from other Alaska rivers and streams; and 4) HSC curves, data and information from other streams and systems outside of Alaska.

For use in the mainstem aquatic habitat model, HSC curves for some species (e.g., benthic macroinvertebrates, fry) will also need to be developed to describe the response of aquatic organisms to relatively short-term flow fluctuations. Some species/lifestages may exhibit similar use of depths and velocities; these species/lifestages may be grouped into guilds to facilitate evaluation of Project effects when considering multiple species and lifestages by seasons. The use of habitat guild curves may be appropriate where species utilization of particular habitat types overlap. HSC for off-channel habitats will include spawning/incubation, and fry/ juvenile rearing lifestages. In addition, specific criteria will be developed for evaluating the connectivity of mainstem flows to off-channel habitats including adult passage into and juvenile fish egress from side channel and side-slough habitats. This element will be coordinated with the Fish Passage/Barrier analysis study described in Section 7.13. Methods to develop HSC for benthic macroinvertebrate and algal habitats are described in the River Productivity study (Section 7.8), and development of HSC/HSI curves for fish is described in the following section.

6.5.4.4.1. Fish HSC/HSI Proposed Methodology

The fish community in the Susitna River is dominated by anadromous and non-anadromous salmonids, although numerous non-salmonid species are also present (See Table 6.5-3). Selection of specific target species for which HSC curves will need to be developed will be done in collaboration with agency and licensing participant representatives.

Development of HSC will involve the following steps.

- Selection of target species/lifestages. For planning purposes, target species are assumed to include Chinook, coho, chum and sockeye salmon, rainbow trout, arctic grayling, and Dolly Varden. Other species and lifestages will be identified in collaboration with agency and licensing participant personnel.
- Develop a Periodicity Table. A species and life stage periodicity table will be developed applicable to the different reaches of the Susitna River. The periodicity information will be used to define temporal and spatial changes in fish species distribution, identify time periods when various life stages (e.g., emergent fry) are present and potentially affected by Project operations, and assist in development of the aquatic habitat modeling efforts.
- Develop Draft HSC Curves. Draft HSC curves for target species and life stages will be developed using 1980s data as well as other available scientific literature for those species. Habitat suitability information will address fish responses to changes in depth, velocity, substrate, cover, groundwater, turbidity, indices of stranding and trapping (depressions and isolated pools), rates of colonization, stranding and trapping mortality, and connectivity to off-channel habitat types.
- Collect Site-Specific Habitat Suitability Information. For target species/lifestages, site-specific habitat suitability information will be collected using HSC-focused biotelemetry, spawning survey field efforts, and fish sampling studies supplemented by information from previous surveys. Habitat use information (water depth, velocity, substrate type, upwelling, turbidity, cover) will be collected at the location of each identified target fish and life stage. Methods will be used for collecting HSC information during seasonal conditions. If possible, a minimum of 100 habitat use observations will be collected for each target species life stage. However, the actual number of measurements targeted for each species and life stage will be based on a statistical analysis that considers variability and uncertainty. While information will be collected on all species and lifestages encountered, the locations, timing and methods of sampling efforts may target key species and lifestages identified in consultation with the technical workgroup,
- Habitat Utilization Frequency Histogram/ Habitat Preference. Histograms (i.e., bar chart) will be developed for each of the habitat parameters (e.g., depth, velocity, substrate, cover, groundwater use, etc.) using the site-specific field observations. The histogram developed using field observations will be compared to the draft HSC curves and literature-based HSC curves. Consideration will also be given to developing HSC curves that are not habitat availability biased (e.g., developed when/where a wide range of habitat availability exists).

- Licensing participant and Expert Panel. If deemed necessary and appropriate by AEA in consultation with licensing participants, a panel of licensing participants and regional experts (agency, Alaska Native entity, industry and university researchers) will be selected to review the HSC data and select final curve sets to be used in the aquatic habitat specific models.

6.5.4.4.2. Work Products

The final work product of this study effort will consist of HSC curves for the target fish species and life stages, and/or habitat guilds. Separate draft reports will be prepared that describe survey methods, results of 2012 review of 1980s HSC data, results of 2013 and 2014 sampling efforts, and discussion of recommendations for final HSC selection. A final report describing survey methods and results and the final selection of HSC curves will be prepared at the end of 2014.

6.5.4.5. Habitat-Specific Models Development

This study component develops the core structures of the aquatic habitat specific models. Development of these models will require careful evaluation of existing data and information as well as focused discussions with technical representatives from the licensing participants. These models will rely in part on information and technical analyses performed in other study components as a basis for developing model structures (e.g., Habitat Mapping; other riverine process studies). Physical habitat models are often used to evaluate alternative instream flow regimes in rivers (e.g., the Physical Habitat Simulation [PHABSIM] modeling approach developed by the U.S. Geological Survey; Bovee 1998, Waddle 2001). Methods available for assessing instream flow needs vary greatly in the issues addressed, their intended use, their underlying assumptions, and the intensity (and cost) of the effort required for the application. Many techniques, ranging from those designed for localized site or specific applications to those with more general utility have been used. The summary review reports of Wesche and Rechard (1980), Stalnaker and Arnette (1976), EA Engineering, Science and Technology (1986), the proceedings of the Symposium on Instream Flow Needs (Orsborn and Allman eds. 1976), Electric Power Research Institute (2000), and more recently the Instream Flow Council (Annear et al. 2004) provide more detailed information on specific methods. The methods proposed in the IFS include a combination of approaches that vary depending on habitat types (e.g., mainstem, side channel, slough, etc.) and the biological importance of those types, as well as the particular instream flow issue (e.g., connectivity/fish passage into the habitats, provision of suitable habitat conditions in the habitats, etc.).

6.5.4.5.1. General Approach – Proposed Methodology

Development of the models will involve completion of a series of tasks as noted below.

- Transect/Study Segment Selection – In coordination with licensing participants and riverine process study leads, use the results of the Habitat Mapping study component to select transects/study segments within each of the selected habitat types identified in the Susitna River to describe habitat conditions based on channel morphology and major habitat features. Additional habitat transects/segments will be selected to describe distinct habitat features such as groundwater areas, spawning and rearing habitats, overwintering habitats, distinct tributary mouths/deltas, and potential areas vulnerable to fish trapping/stranding. The transects used for defining the flow routing model will also be integrated into this analysis.

- Agency/Licensing participant Site Reconnaissance – Conduct a site reconnaissance with personnel from agencies, Alaska Native entities and other licensing participants to review river reaches, select candidates study sites and potential transect/study segment locations, and discuss options for model development. This reconnaissance trip has been scheduled for early-mid September and will encompass a 3-4 day effort. The first day will be an office based meeting during which specific methods will be reviewed and their applicability to addressing specific questions will be discussed, and the field itinerary reviewed. This will be followed by a 1-2 day field reconnaissance of representative habitat types including but not limited to mainstem channel, side channels, side sloughs, and upland sloughs. Stops will be made at each of these habitat types and assessment methods will be discussed, with the goal of reaching consensus on which methods will be applied for evaluating flow-habitat relationships. Participants will reconvene in the office on the final day of the trip to discuss observations and reach agreement on assessment methods.
- Model Selection: Field Surveys and Data Collection – Once study sites and transects/study segments have been identified, detailed field surveys will begin. These will be tailored based on habitat types to be measured and the selected models to be used. It is likely this will involve a combination of 1-D and 2-D modeling approaches as well as application of empirically based methods such as the RJHAB model applied in the 1980s studies (ADF&G 1984L). The RJHAB model was used to assess/model the effects of flow alterations on juvenile fish habitat for off-channel areas. At this time, it is anticipated that two-dimensional modeling will be applied to one or more representative reaches in the middle river. For this, a multi-stepped approach will be used so that after each field data collection effort, topographic data will be projected via computer analysis to identify locations requiring the collection of more data points. Table 6.5-2 provides a listing of potential models/methods that will be considered as part of the IFS. The most appropriate methods for selected study sites will be determined via careful review of site conditions and the underlying questions needing to be addressed. Methods selection will be done as a collaborative process within the IFS-TWG.

Regardless of specific method, field surveys will involve measurement of water velocities, water depths, water surface elevations, bottom profiles/topography, substrate characteristics, and other relevant data (e.g., upwelling, water temperature) under different flow conditions. One of the tasks for 2012 is to evaluate and determine specific flow targets for these field surveys.

6.5.4.5.2. Hydraulic – Habitat Model Integration

Susitna mainstem flow routing models (HEC-ResSim; HEC-RAS; CRISSP1D and/or other routing models) will provide hourly flow and water surface elevation data at numerous locations longitudinally distributed throughout the length of the river extending downstream from RM 184. Two different flow routing models will be developed: a summer ice-free model (HEC-RAS); and a winter model to route flows under ice-covered conditions (CRISSP1D). Output from the flow routing model will provide the fundamental input data to a suite of habitat specific and riverine process models that will be used to describe how the existing flow regime relates to and has influenced various resource elements (e.g., salmonid spawning and rearing habitats, invertebrate habitat, sediment transport processes, ice dynamics, large woody debris (LWD), the composition and structure of riparian floodplain vegetation). These same models will likewise be used to evaluate fish habitat responses to alternate Project operational scenarios. As an unsteady flow model, the routing model will be capable of providing flow and water surface elevations on an hourly basis and therefore Project effects on flow can be evaluated on multiple time steps (hourly, daily, monthly) as necessary to evaluate different resource elements.

Habitat-specific models represent the core analytical tools for assessing potential Project effects on fish and aquatic resources. These models will integrate the habitat-hydraulic modeling and biological information on the distribution, timing, abundance, and suitability of habitats to estimate a variety of metrics (habitat-flow responses, time series, habitat durations, passage conditions, varial zone areas and frequency of inundation and dewatering, incubation conditions [temperature]) that will be used to compare the effects of Project operational scenarios and support licensing decisions.

6.5.4.5.3. Habitat Weighted Usable Area/Habitat Metrics

The methods proposed in the IFS will include a combination of approaches depending on habitat types (e.g., mainstem, side channel, slough, etc.) and the biological importance of those types, as well as the particular instream flow issue (e.g., connectivity/fish passage into the habitats, provision of suitable habitat conditions in the habitats, etc.). During the 1980s studies, methods were designed to focus on both mainstem and off-channel habitats, although mainstem analysis was generally limited to near-shore areas. PHABSIM-based 1-D models, juvenile salmon rearing habitat models, fish passage models, and others were employed and will be considered as part of the IFS plan. As part of the 2013-2014 study efforts, more rigorous approaches and intensive analyses will be applied to habitats determined as representing especially important habitats for salmonid production. This will include both 1-D and 2-D hydraulic modeling that can be linked to habitat based models.

As part of the Geomorphology Modeling Study (Section 5.9), several 2-D models are being considered including the Bureau of Reclamation's SRH2-D, USACE's Adaptive Hydraulics ADH, the U.S. Geological Survey's (USGS) MD_SWMS suite, DHIs MIKE 21, and the suite of River2D models (see Section 5.9 for a description of various 2-D model attributes and references). The River2D model is a two-dimensional, depth-averaged finite-element hydrodynamic model developed at the University of Alberta that is capable of simulating complex, transcritical flow conditions. River2D also has the capability to assess fish habitat using the PHABSIM weighted-usable area approach (Bovee, 1982). Habitat suitability indices are input to the model and integrated with the hydraulic output to compute a weighted useable area at each node in the model domain. While evaluation of habitat indices directly incorporated into the River2D suite of models, other 2-D models are also complementary to habitat evaluations. Selection of potential 2-D models for fish and aquatics evaluations will be coordinated with other pertinent studies and the Licensing participants.

The models noted above will be used to translate changes in water surface elevation/flow at each of the measured transects/study segments into changes in depth, velocity, substrate, cover and other potential habitat (e.g., turbidity, upwelling). Linking this information with HSC/HSI curves will allow for translation of changes in hydraulic conditions resulting from Project operations into indices of habitat suitability. This will allow for the quantification of habitat areas containing suitable habitat indices for target species and life stages of interest for baseline conditions and alternate operational scenarios.

In response to the effect of potential load-following operations, habitat modeling using weighted usable area indices may need to be developed using both daily and hourly time steps. Evaluating the effects of changes in habitat conditions on an hourly basis may require additional habitat-specific models such as effective habitat and varial zone modeling.

6.5.4.5.4. Effective Habitat and Varial Zone Modeling

The risk of salmonid redd dewatering and scour will be assessed by developing an effective spawning/incubation model. Spawning/incubation analyses will be based on identifying potential use of a small, discrete channel area (cell) by spawning salmonids on an hourly basis and then tracking that cell through the subsequent egg and alevin incubation periods to determine whether that cell was subject to dewatering or scour. Within each cell, the maximum and minimum stage for spawning to occur will be identified based on the range of flow depths and velocities between those two stages. Use of that cell by spawning fish is assumed to occur if substrate conditions are suitable and habitat suitability indices for both depth and velocity are within an acceptable range. HSC/HSI information used to develop the effective spawning/incubation model will be developed in consultation with the licensing participants as part of the previously described section on HSC development.

A varial zone habitat model will be developed to quantify the magnitude, frequency and duration of the channel area that may be exposed to inundation and dewatering. The varial zone analysis will be conducted by discrete portions of each of the habitat types (e.g., mainstem, side channel, sloughs) using an hourly time step integrated over a specified period that considers fluctuations in water surface elevations that occurred during the period. The varial zone is defined as the area between the high water surface elevation and the low water surface elevation for a given project operating range using a span of time periods reflective of the aquatic species and life stage of interest. The selection of time periods to define the upper and lower extent of the varial zone for the Project will be coordinated with licensing participants. However, for planning purposes, three time scales are being considered: 12 hours, 7 days and 30 days. A 12-hour time series may provide an indication of the effects of water level changes on aquatic biota that rapidly colonize a previously dewatered area. Salmonid fry and some benthic macroinvertebrate may rapidly recolonize or occupy a previously dewatered area when they are moving downstream from upstream areas during outmigration or a result of displacement from upstream areas. A 7-day time series may be used as an indicator of the risk of dewatering due to hourly and daily changes in load-following operations, such as weekday versus weekend generation. Some aquatic organisms may require several days to colonize an area, or the density of organisms may increase rapidly over the first several days of access to a previously dewatered area. A 30-day time series can be used as an indicator of the risk of dewatering associated with weekly to monthly changes in flow patterns, such as changes in minimum flow requirements or seasonal runoff. A complex assemblage of benthic macroinvertebrates may require weeks to months to become established along channel margins. Information on the rate of colonization, dewatering mortalities and conditions supporting suitable habitats for organisms of interest will be developed as part of the HSC/HSI study component. Figures 6.5-5 and 6.5-6 illustrate the concept of a varial zone and the framework for the varial zone model.

6.5.4.5.5. Fish Passage/Off-channel Connectivity

The extent to which mainstem flows dictate connectivity to off-channel habitats will be evaluated via development of models that consider the depth, velocity and substrate requirements of adult salmon upstream migrations as well as juvenile downstream movements. This analysis will be completed on a representative number of the different habitat types found in the Susitna River including side channels, side-sloughs, and upland sloughs. Candidate locations for this analysis will be identified during the 2012 Agency Field Reconnaissance trip scheduled for September. To the extent applicable, the analysis will utilize information and modeling results developed during the 1980s studies, but entirely new studies will be completed as a means to test the results of the earlier studies, as well as to apply new technologies in making this evaluation (e.g., possible application of 2-D modeling). This work will be closely coordinated with and linked to the Fish Barrier Analysis study described in Section 7.12 of this study plan.

6.5.4.5.6. Temporal Habitat Analyses

The hydraulic-routing and habitat models will be used to process output from the ROM. This will be done for each scenario and hydrologic period and will allow for the quantification of Project operation effects on:

- Habitat areas (for each habitat type – mainstem, side channel, slough, etc.) by species and life stage;
- Varial zone area;
- Effective spawning areas for fish species of interest (i.e., spawning sites remain wetted through egg hatching);
- Other riverine processes that will be the focus of the Geomorphology (Section 5.8 and 5.9), Water Quality (Section 5.5), and Ice Processes (Section 5.10) studies including mobilization and transport of sediments, channel form and function, water temperature regime, and ice formation and decay timing. The IFS studies will be closely linked with these studies and will incorporate various model outputs in providing a comprehensive evaluation of instream flow related effects on fish and aquatic biota and habitats.

The various indices of Project effects on aquatic habitats will be summarized and tabulated to allow ready comparison of the effects of alternative operational scenarios. It is anticipated that the varial zone and effective habitat analysis will be used as a primary indicator of the effects of operational scenarios related to relatively short-term flow alterations. Analyses of habitat area will be developed for each species and life stage of interest (or as combinations of species via habitat guilds), and the results will be used in part for identifying the spatial distribution of potential habitats. Each indicator of environmental effect will be tallied separately, and the relative importance of the effects of Project operations on various aquatic resources can be determined independently by interested parties.

6.5.4.5.7. Work Products

At a minimum, reports will be prepared at the end of each year of study that will describe the methods and results of the IFS components completed during that year. There will be other technical information prepared throughout the duration of the IFS including \ describing flow routing, fish and aquatics study site selection, HSC field methods, HSC and peridiocity development, habitat modeling, and habitat analyses.

6.5.5. Consistency with Generally Accepted Scientific Practice

The proposed IFS, including methodologies for data collection, analysis, modeling, field schedules, and study durations, is consistent with generally accepted practice in the scientific community. The study plans were collaboratively developed with technical experts representing the applicant, state and federal resource agencies, Alaska Native entities, non-government organizations and the public. Many of these technical experts have experience in multiple FERC licensing and relicensing proceedings. The IFS is consistent with common approaches used for other FERC proceedings and the IFS reference specific protocols and survey methodologies, as appropriate.

6.5.6. Schedule

The schedule for completing all components of the Mainstem Aquatic Habitat Model is provided in Table 6.5-4. Licensing participants will have opportunities for study coordination through regularly scheduled meetings, reports and, as needed, technical subcommittee meetings. Initial and Updated Study Reports will be issued in December 2013 and 2014, respectively. Reports are planned for preparation at the end of 2013 and 2014 for each of the study components. Workgroup meetings are planned to occur on at least a quarterly basis, and workgroup subcommittees will meet or have teleconferences as needed.

6.5.7. Level of Effort and Cost

Based on a review of study costs associated with similar efforts conducted at other hydropower projects, and in recognition of the size of the project and logistical challenges and costs associated with the remoteness of the site, study costs associated with the instream flow study are expected to be approximately $5,000,000 to $6,000,000. Estimated study costs are subject to review and revision as additional details are developed.

Portions of this study will be conducted in conjunction with water resource, geomorphology, water quality, operational modeling, and fisheries and aquatic resource studies; however, specific costs of those studies will be reflected in those individual study plans.

6.5.8. Literature Cited

[ADF&G] Alaska Department of Fish and Game. 1981a. Aquatic studies procedures manual: Phase I. Su-Hydro Aquatic Studies Program. Anchorage, Alaska. Susitna Hydro document no. 3506.

—. 1981b. Subtask 7.10 Phase 1 Final Draft Report Resident Fish Investigation on the Upper Susitna River. Alaska Department of Fish and Game, Anchorage, Alaska.

—. 1982. Upper Susitna River Impoundment Studies 1982. ADF&G. Anchorage, Alaska.

—. 1983a. Susitna Hydro aquatic studies phase II final report. Adult anadromous fish studies, 1982, volume 2. Susitna Hydro Document No. 588, Anchorage, Alaska.

—. 1983b. Aquatic Habitats and Instream Flow Studies Parts I and II. Susitna Hydro Aquatic Studies Phase II Basic Data Report volume 4, Susitna Hydro Document No. 585. Anchorage, Alaska.

—. 1984a. Susitna Hydro aquatic studies report no. 1. ADF&G, Susitna Hydro Aquatic Studies Report Series, Susitna Hydro Document No. 1450, Anchorage, Alaska.

—. 1984b. Population Dynamics of Arctic Grayling in the Upper Susitna Basin, Report 4, Part II. Schmidt, D.C., C. Estes, D. Crawford, and D. Vincent-Lang, editor. Access and Transmission Corridor Aquatic Investigations (July–October 1983). Susitna Hydro Document No. 2049. ADF&G, Anchorage.

—. 1984c. Susitna Hydro Aquatic Studies Report No. 2. Resident and juvenile anadromous fish investigations (May–October 1983). D.C. Schmidt, S.S. Hale, D. L. Crawford, and P.M. Suchanek, editors. Prepared for the Alaska Power Authority, Susitna Hydro Document No. 1784, ADF&G, Anchorage, Alaska.

—. 1984d. Aquatic Habitat and Instream Flow Investigations (May–October, 1983). Chapter 1. Stage and Discharge Investigations – 1984. Susitna Hydro Document No. 1930. ADF&G, Anchorage, Alaska.

—. 1984e. Aquatic Habitat and Instream Flow Investigations (May–October, 1983). Chapter 2. Channel Geometry Investigations. Susitna Hydro Document No. 1931. ADF&G, Anchorage, Alaska.

—. 1984f. Aquatic Habitat and Instream Flow Investigations (May–October, 1983). Chapter 3. Continuous Water Temperature Investigations. Susitna Hydro Document No. 1932. ADF&G, Anchorage, Alaska.

—. 1984g. Aquatic Habitat and Instream Flow Investigations (May–October, 1983). Chapter 5. Eulachon Spawning Habitat – 1984. Susitna Hydro Document No. 1934. ADF&G, Anchorage, Alaska.

—. 1984h. Aquatic Habitat and Instream Flow Investigations (May–October, 1983). Chapter 6. An evaluation of passage conditions for adult salmon in sloughs and side channels of the Middle Susitna River. Susitna Hydro Document No. 1935. ADF&G, Anchorage, Alaska.

—. 1984i. Aquatic Habitat and Instream Flow Investigations, (May–October, 1983). Chapter 7. An evaluation of chum and sockeye salmon spawning habitat in sloughs and side channels of the Middle Susitna River. Susitna Hydro Document No. 1936. ADF&G, Anchorage, Alaska.

—. 1984j. Aquatic Habitat and Instream Flow Investigations, (May–October, 1983). Chapter 8. Evaluation of chum salmon spawning habitat. Susitna Hydro Document No. 1937. ADF&G, Anchorage, Alaska.

—. 1984k. Aquatic Habitat and Instream Flow Investigations, (May–October, 1983). Chapter 9. Habitat suitability criteria for Chinook, coho and pink salmon spawning in tributaries of the Middle Susitna River. Susitna Hydro Document No. 1938. ADF&G, Anchorage, Alaska.

—. 1984k. Aquatic Habitat and Instream Flow Investigations, (May–October, 1983). Modeling of juvenile salmon and resident fish habitat. Susitna Hydro Development Part 7. ADF&G, Anchorage, Alaska.

Addley, C. 2006. Habitat modeling of river ecosystems: Multidimensional spatially explicit and dynamic habitat templates at scales relevant to fish. Ph.D. dissertation. Utah State University, Logan, Utah.

Annear, T., I. Chisholm, H. Beecher, A. Locke and 12 other authors. 2004. Instream flows for riverine resource stewardship, revised edition. Instream Flow Council, Cheyenne, WY. 268 pp

Bovee, K. D. 1982. A guide to stream habitat analysis using the Instream Flow Incremental Methodology. Instream Flow Paper No. 12. Washington, DC: U.S. Fish and Wildlife Service (FWS/OBS-82/26).

Bovee, K. D. 1986. Development and evaluation of habitat suitability criteria for use in the instream flow incremental methodology. Washington, DC: U.S. Fish and Wildlife Service (Biological Report 86[7]). 235pp.

Crance, J. 1987. Guidelines for Using the Delphi Technique to Develop Habitat Suitability Index Curves. US Fish and Wildlife Service Biological Report 82(10.134). Fort Collins, CO. 22 pp.

DeVries, P., B. Kvam, S. Beck, D. Reiser, M. Ramey, C. Huang, and C. Eakin. 2001. Kerr Hydroelectric Project, Lower Flathead River ramping rate study. Prepared by R2 Resource Consultants, for Confederated Salish and Kootenai Tribes of the Flathead Nation, Montana.

Dugan, L.J., D. A. Sterritt, and M.E. Stratton. 1984. The distribution and relative abundance of juvenile salmon in the Susitna River drainage above the Chulitna River confluence. Alaska Department of Fish and Game. Completion Report. Susitna Hydroelectric Studies. Anchorage, Alaska.

EA Engineering, Science, and Technology, Inc. 1986. Instream flow methodologies. Electric Power Research Institute (EPRI). EPRI EA-4819, Project 2194-2, Final Report.

Electric Power Research Institute (EPRI). 2000. Instream flow assessment methods: guidance for evaluating instream flow needs in hydropower licensing. Electric Power Research Institute (EPRI). Report number 1000554.

Hardy Thomas B., and Tarbet Karl, 1996. *Evaluation of one-dimensional and two-dimensional hydraulic modeling in a natural river and implications in instream flow assessment methods*. Proceedings of Second International Symposium on Habitat Hydraulics Ecohydraulics 2000, Quebec, Canada, June 1996, Volume B, 395-406.

HDR Alaska. 2011. Susitna-Watana Hydroelectric Project; Railbelt Large Hydro; Aquatic Resources Data Gap Analysis. Prepared for Alaska Energy Authority, Anchorage, Alaska.

Klemm, D.J., P.A. Lewis, F. Fulk, and J.M. Lazorchak. 1990. Macroinvertebrate field and laboratory methods for evaluating the biological integrity of surface waters. EPA/600/4-

90/030, Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio.

Leclerc, M., Boudreault A., Bechara, J. A., and Corfa, G., 1995. Two-dimensional hydrodynamic modeling-a neglected tool in the instream flow incremental methodology. Transactions of the American Fisheries Society 124(5), 645-662.

Marshall, R. P., P. M. Suchanek, and D.C. Schmidt. 1984. Juvenile salmon rearing habitat models. Report No. 2, Part 4. Susitna Hydro Aquatic Studies, Alaska Department of Fish and Game, Anchorage, Alaska.

Murphy, B. R. and D. W. Willis. 1996. Fisheries Techniques, Second Edition. American Fisheries Society, Bethesda Maryland. 732 pp.

Orsborn, J.F. and C.H. Allman (editors). 1976. Proceedings of the symposium and specialty conference on instream flow needs. American Fisheries Society, Bethesda, Maryland 20014. Volume I & II.

Perry, S.A. and W.B. Perry. 1986. Effects of experimental flow regulation on invertebrate drift and stranding in the Flathead and Kootenai rivers, Montana, USA. Hydrobiologia. 134: 171 182.

R2 Resource Consultants, Inc. 2003. Baker River Project Relicensing (FERC No. 2150), Large Woody Debris Budget, Aquatic Resource Study A-20. Prepared by R2 Resource Consultants, Redmond, WA, prepared for Puget Sound Energy, Inc., Bellevue, WA. 105 pp.

R2 Resource Consultants, Inc. 2004. Baker River Project Relicensing (FERC No. 2150), Lower Baker Physical Habitat Mapping, Aquatic Resource Study A-02. Prepared by R2 Resource Consultants, Redmond, WA, prepared for Puget Sound Energy, Inc., Bellevue, WA. 105 pp.

Rabeni, C. F. 1996. Invertebrates. Chapter 11 in Murphy, B. R. and D. W. Willis. (eds) Fisheries Techniques, Second Edition. American Fisheries Society, Bethesda Maryland.

Reice, S.R. and M. Wohlenberg. 1993. Monitoring freshwater benthic invertebrates and benthic processes: Measures for assessment of ecosystem health. Pages 287-305 in D.M. Rosenberg and V.H. Resh, editors. Freshwater biomonitoring and benthic macroinvertebrates. Routledge, Chapman and Hall, Inc., New York, New York.

Reiser, D.W, T. Nightengale, N. Hendrix, and S. Beck. 2005. Effects of pulse-type flows on benthic macroinvertebrates and fish: a review and synthesis of information. Report prepared by R2 Resource Consultants for Pacific Gas and Electric Company, San Ramon, California.

Stalnaker, C. and J. Arnette (eds). 1976. Methodologies for the determination of stream resource maintenance flow requirements: an assessment. U.S. Fish and Wildlife Service, Western Water Allocation.

Stalnaker, C., B.L. Lamb, J. Henriksen, K. Bovee, and J. Bartholow. 1995. The instream flow incremental methodology, a primer for IFIM. National Biological Service, U.S. Department of the Interior. Biological Report 29.

Tarboton, K. C., Irizarry-Ortiz, M. M., Loucks, D. P., Davis, S. M., and Obeysekera, J. T. 2004. Habitat Suitability Indices for Evaluating Water Management Alternatives. Office of Modeling Technical Report. South Florida Water Management District, West Palm Beach, Florida. December, 2004.

Thorp, J.H. and A.P. Covich. 2001. An overview of freshwater habitats. Pages 19-41 *in* J.H. Thorp and A.P. Covich, editors. Ecology and classification of North American freshwater invertebrates. Academic Press, San Diego, California.

Troelstrup, N.H., Jr. and G.L. Hergenrader. 1990. Effect of hydropower peaking flow fluctuations on community structure and feeding guilds of invertebrates colonizing artificial substrates in a large impounded river. Hydrobiologia 199: 217 228.

U.S. Army Corps of Engineers. 2001. UNET One-dimensional unsteady flow through a full network of open channels, User's manual, CPD-66.

U.S. Army Corps of Engineers. 2002a. HEC-RAS River Analysis System User's Manual, CPD-68.

U.S. Army Corps of Engineers. 2002b. HEC-RAS River Analysis System Hydraulic Reference Manual, CPD-69.

U.S. Army Corps of Engineers. 2002c. HEC-RAS River Analysis System Applications Guide, CPD-70.

USFWS (U.S. Fish and Wildlife Service). 1980. Habitat evaluation procedures (HEP). ESM 102. U.S. Fish and Wildlife Service, Division of Ecological Services, Washington, D.C. March 31, 1980.

USFWS (U.S. Fish and Wildlife Service). 1981. Standards for the development of habitat suitability index models for use in the Habitat Evaluation Procedures, USDI Fish and Wildlife Service. Division of Ecological Services. ESM 103.

Wesche, T. A., and P. A. Rechard. 1980. A summary of instream flow methods for fisheries and related research needs. Eisenhower Consortium Bulletin 9. Water Resources Research Institute, University of Wyoming, Laramie, Wyoming. 122 p.

6.5.9. Tables

Table 6.5-1. Selected sites measured and models applied in the reach of the Susitna River extending below Devil Canyon to Chulitna River during the 1980s studies. Source Estes and Vincent-Lang (1984). Mainstem flows that overtopped respective habitats are also displayed.

Site	Model Applied	Overtopping Discharge (cfs)
Lower side channel 11	IFG-2	5,000
Side channel 10A	RJHAB	9,000
Side channel 21	IFG-4	9,000
Upper side channel 11	IFG-4	13,000
Slough 9	IFG-4	16,000
Slough 21	IFG-4	18,000/23,000
Side channel 10	IFG-4	19,000
Slough 22	RJHAB	20,000
Whiskers Slough	RJHAB	22,000
Slough 8	RJHAB	25,000
Slough 8A	IFG-4	33,000
Slough 5	RJHAB	Upland slough
Slough 6A	RJHAB	Upland slough

Table 6.5-2. Assessment of physical and biological processes and potential habitat modeling techniques.

Physical & Biological Processes	Habitat Types			
	Mainstem	Side Channel	Slough	Tributary Mouths
Spawning	PHAB/VZM	PHAB	PHAB/HabMap	PHAB/RFR
Incubation	RFR/VZM	PHAB	PHAB/HabMap	PHAB/RFR
Juvenile Rearing	PHAB/RFR	PHAB	PHAB/HabMap	PHAB/RFR
Adult Holding	RFR	RFR	PHAB/HabMap	PHAB/RFR
Macroinvertebrates	VZM/WP	VZM/WP	PHAB/HabMap/WP	NA
Standing/Trapping	VZM	VZM	VZM/WP	VZM/WP
Upwelling/Downwelling	FLIR	HabMap/FLIR	HabMap/FLIR	HabMap/FLIR
Temperature	WQ	WQ	WQ	WQ
Ice Formation	IceProcesses/WQ/RFR	IceProcesses/WQ/RFR	HabMap/Open leads	NA

Notes:

1. PHAB-Physical Habitat Simulation Modeling (1D, 2D, and empirical); VZM-Effective Spawning and Incubation/Varial Zone Modeling; RFR-River Flow Routing Modeling; FLIR - Forward-looking Infrared Imaging; HabMap-Surface Area Mapping; WQ-Water Quality Modeling; WP-Wetted Perimeter Modeling.

Table 6.5-3. Common names, scientific names, life history strategies, and habitat use of fish species within the lower, middle, and upper Susitna River, based on sampling during the 1980s (from HDR 2011).

Common Name	Scientific Name	Life History	Susitna Usage
Arctic grayling	*Thymallus arcticus*	F	O, R, P
Dolly Varden	*Salvelinus malma*	A,F	O, P
Humpback whitefish	*Coregonus pidschian*	A,F	O, R, P
Round whitefish	*Prosopium cylindraceum*	F	O, M2, P
Burbot	*Lota lota*	F	O, R, P
Longnose sucker	*Catostomus catostomus*	F	R, P
Sculpin	*Cottid spp.*	M1, F	P
Eulachon	*Thaleichthys pacificus*	A	M2, S
Bering cisco	*Coregonus laurettae*	A	M2, S
Threespine stickleback	*Gasterosteus aculeatus*	A,F	M2, S, R, P
Arctic lamprey	*Lethenteron japonicum*	A,F	O, M2, R, P
Chinook salmon	*Oncorhynchus tshawytscha*	A	M2, R
Coho salmon	*Oncorhynchus kisutch*	A	M2, S, R
Chum salmon	*Oncorhynchus keta*	A	M2, S
Pink salmon	*Oncorhynchus gorbuscha*	A	M2
Sockeye salmon	*Oncorhynchus nerka*	A	M2, S
Rainbow trout	*Oncorhynchus mykiss*	F	O, M2, P
Northern pike	*Esox lucius*	F	P
Lake trout	*Salvelinus namaycush*	F	U
Pacific lamprey	*Lampetra tridentata*	A,F	U
Alaska blackfish	*Dallia pectoralis*	F	U

Notes:

A = anadromous
M1 = marine
F = freshwater
O=overwintering
R=rearing
P=present
M2 = migration
S=spawning
U=unknown

Table 6.5-4. Schedule for development of all aquatic habitat components of the Instream Flow Study.

Activity	2012				2013				2014				2015			
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4Q	1 Q	2 Q	3 Q	4Q
Finalize Study Plan		--------	--------	--●--												
Agency Licensing participant Site Visit			----▲--													
Study Site Selection (mainstem, slough, side channels, etc.)			----▲--	-------●												
Review of 1980s Data and Information		--------	--------	-------●												
Model Selection by habitat type (1-D, 2-D, mapping, etc.)			--------	-------●												
Hydraulic Routing: data collection and reporting		--------	--------	-------●	--------	--------	--------	-------●	--------	--------	--------	-------●				
Hydraulic Routing: develop executable model			--------	-------●	--------	--------	--------	-------●	--------	--------	--------	-------●				
HSC/Periodicity Fish: Review literature and 1980s reports			-------	-------●	--------	--------	--------	-------●	--------	--------	--------	-------●				
HSC Fish: Field data collection (summer, fall, winter) (both years)			▲-	----▲-	--------	---▲----	-▲-------	-▲--	●-------	--▲------	--▲--	-------●				
Coordinate Habitat Mapping (GIS, aerial videography, aerial photography)		-------	-------	-------●	-------	-------	--------	-------●								
Habitat Surveys (side channels, sloughs, mainstem)					-------	-------	--▲---	-------●	-------	--▲-----	--▲---	-------●				
Collect Physical and Hydraulic Data					-------	--▲---	▲--▲	-------●	-------	▲--▲	▲----	-------●				
Coordinate groundwater/surface flow models				------	------	------	------	-------●	-------	-------	-------	-------●				
Hydraulic Model Integration and Calibration							------	-------●	-------	-------	-------	-------●				
Varial Zone Model and Downramping Analysis							------	-------●	-------	-------	-------	-------●				
Habitat Modeling							------	-------●	-------	-------	-------	-------●				
Alternate Scenario Post-Processing											-------	-------●	-------	-------		
Reporting				●	-------	-------	-------	-------●	-------	-------	-------	-------●	-------	-------		
License Application Support											-------	-------	------●	------●		

Notes:

▲ = field activity
● = reporting
--- = activity

6.5.10. Figures

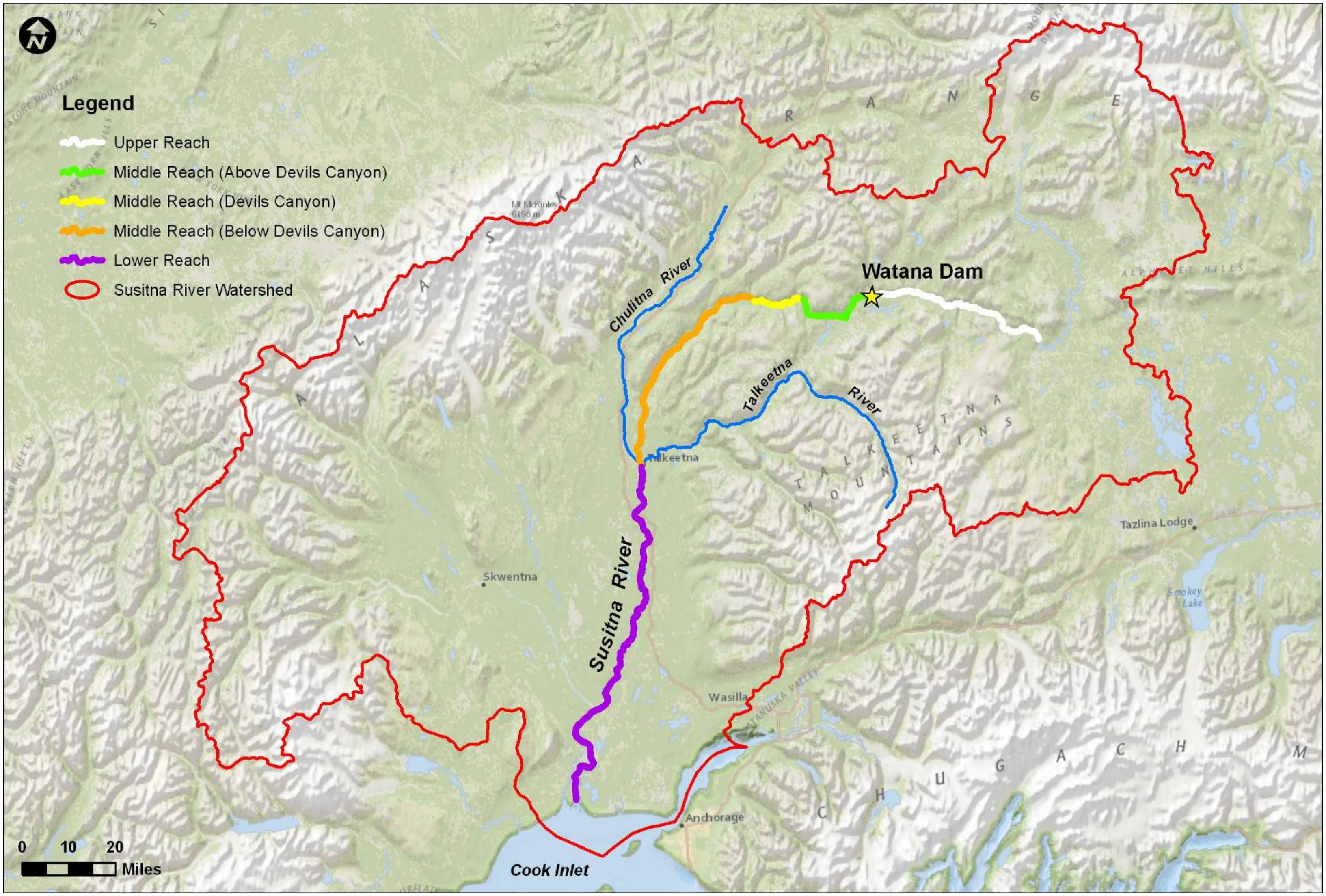


Figure 6.5-1. Map of the Susitna River influenced by Susitna-Watana Hydroelectric Project.

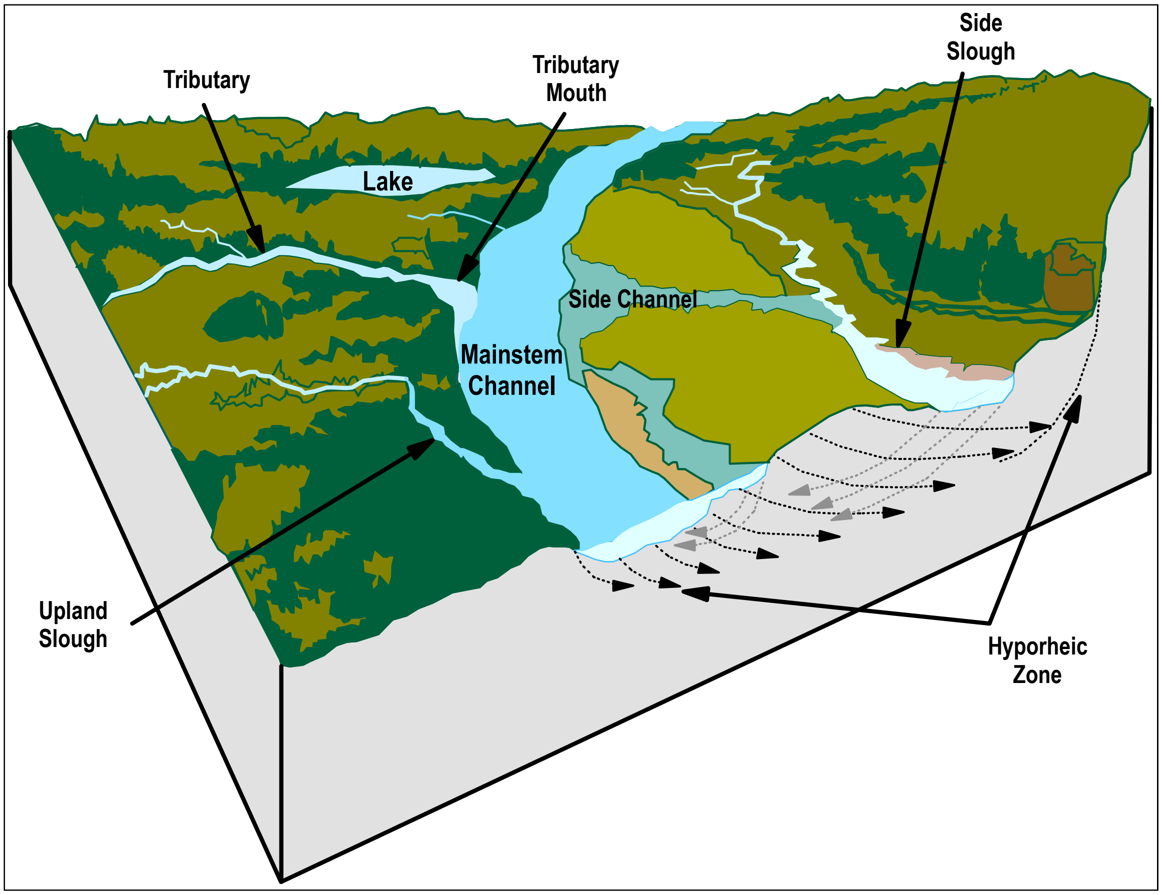


Figure 6.5-2. Habitat types identified in the middle reach of the Susitna River during the 1980s studies (adapted from ADF&G 1983, Trihey 1982).

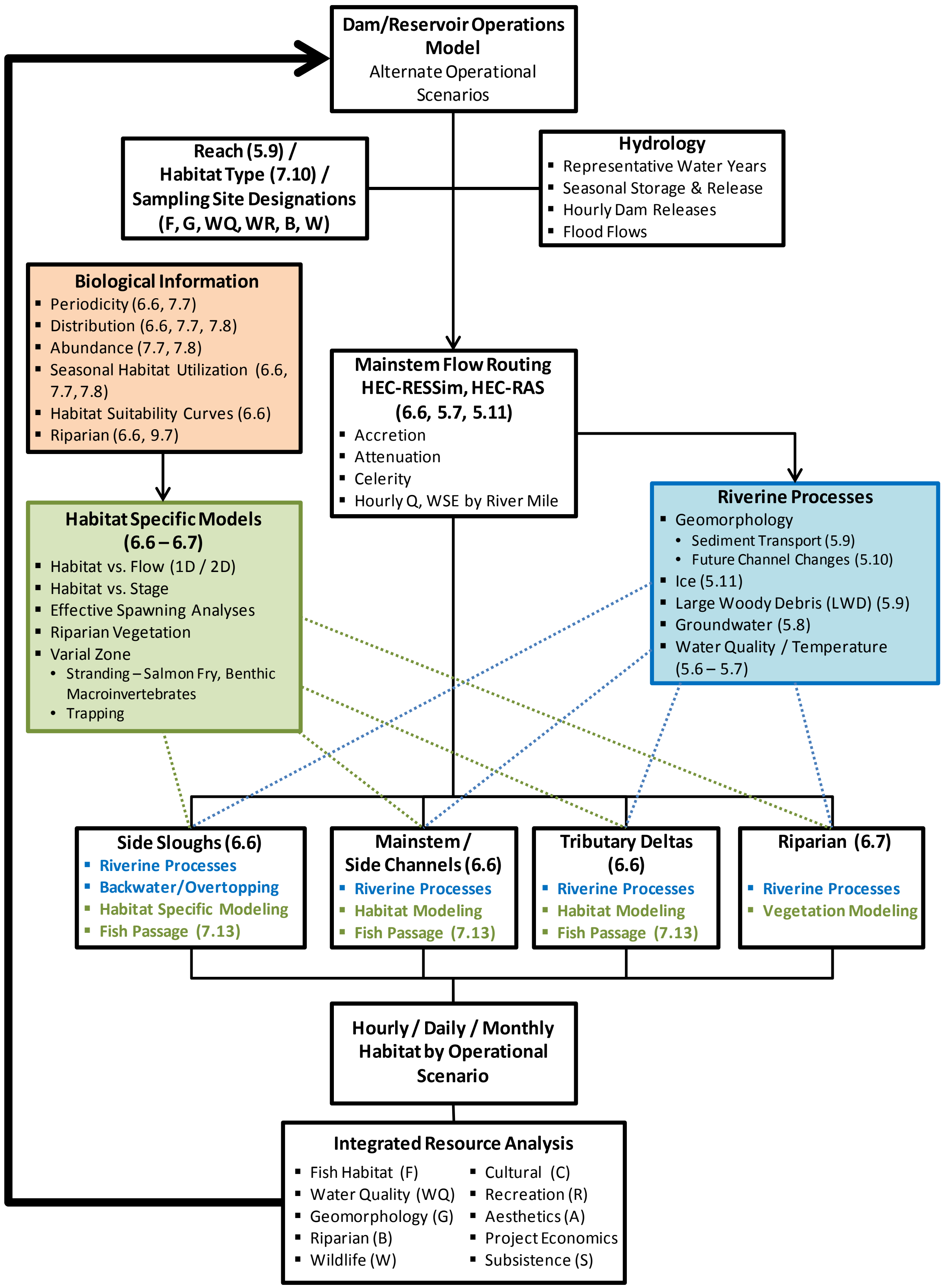


Figure 6.5-3. Conceptual framework for the Susitna –Watana Instream Flow Study depicting linkages between habitat specific models and riverine processes that will lead to an integrated resource analysis.

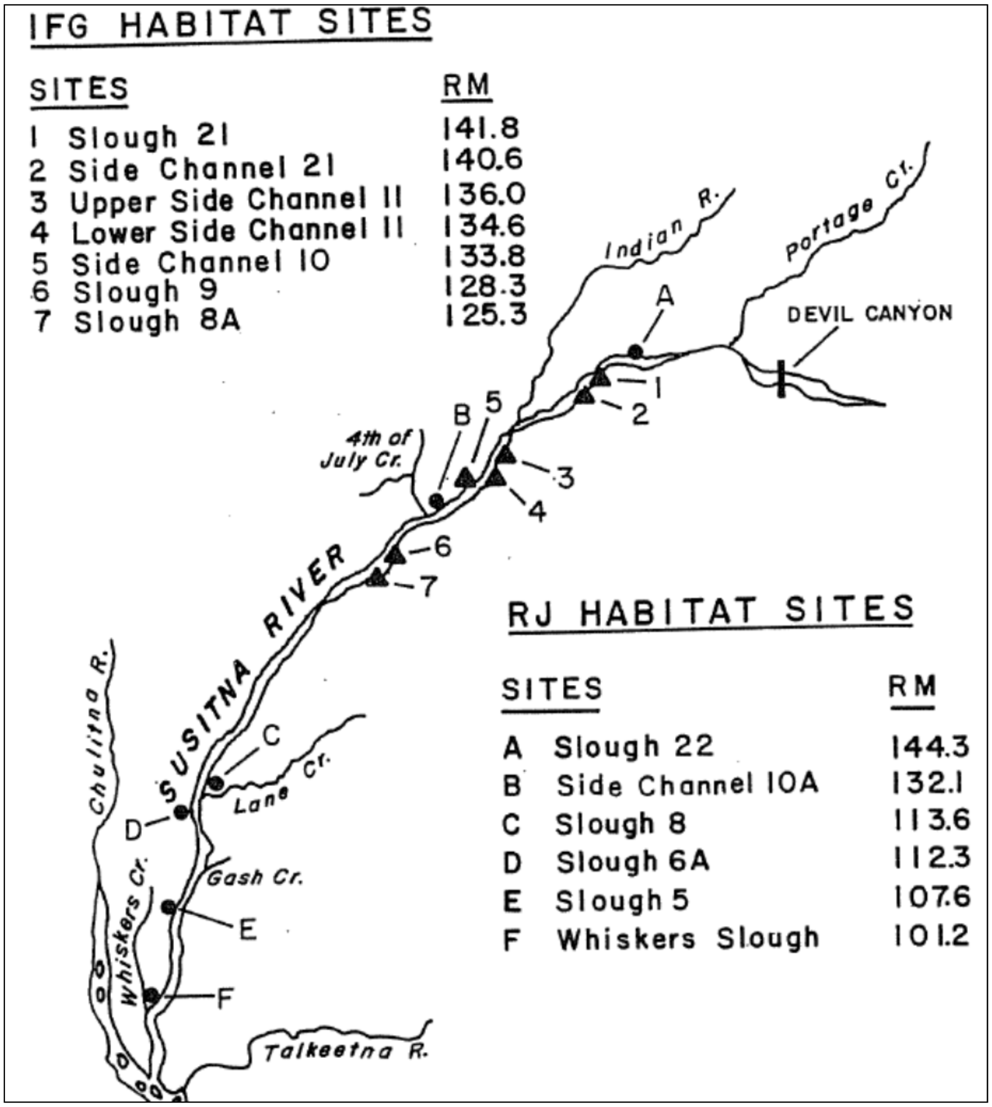


Figure 6.5-4. Location of sloughs and side channels modeled during 1980s studies. Source Estes and Vincent-Lang (1984).

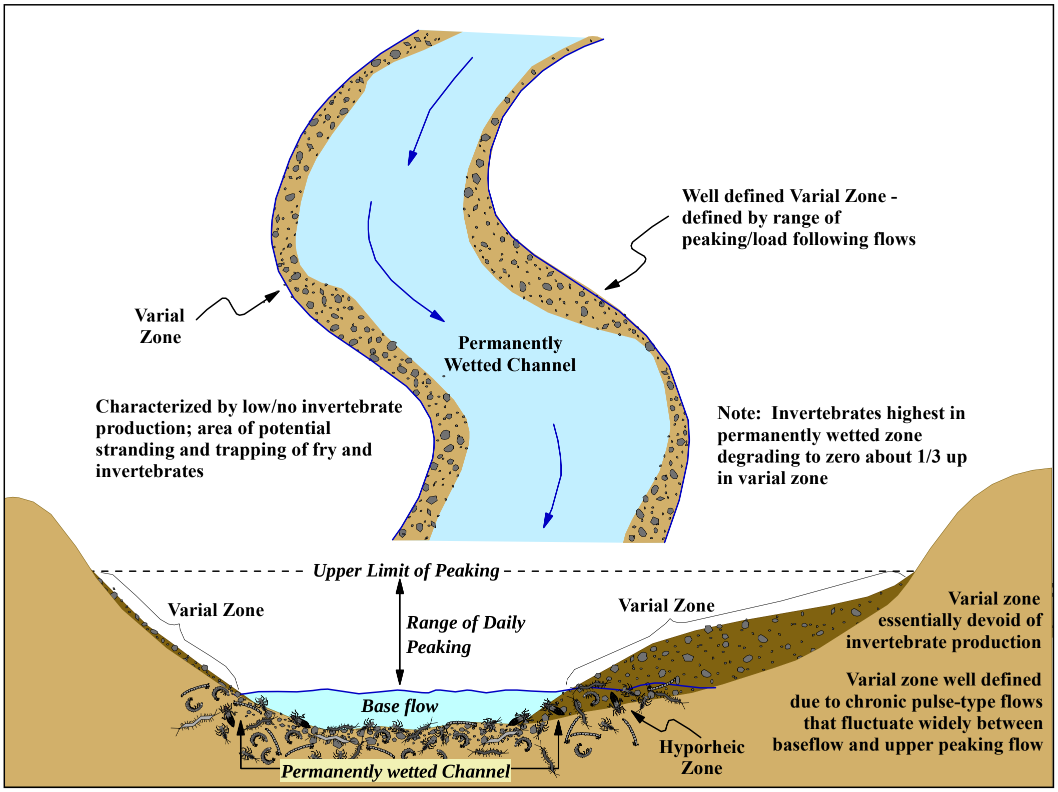


Figure 6.5-5. Schematic diagram illustrating the formation of a varial zone within a river channel.

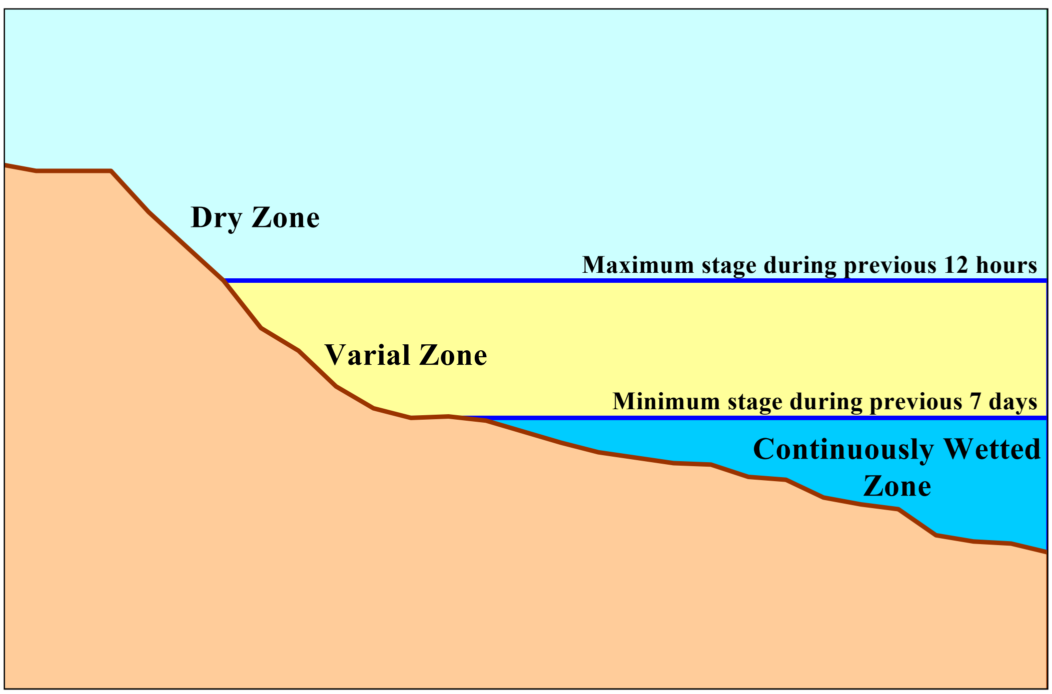


Figure 6.5-6. Conceptual framework of the varial zone model.

6.6. Riparian Instream Flow Study

6.6.1. General Description of the Proposed Study

6.6.1.1. Focus of Riparian IFS

The 2013-2014 Riparian IFS is directed toward providing a physical and vegetation process modeling approach to predicting potential impacts to downstream riparian floodplain vegetation from modification of natural Susitna River flow, sediment, and ice processes regimes resulting from Project operational flows. The focus of much of this work will be on establishing a set of analytical tools/models based on the best available science, information and data that can be used for defining both baseline conditions; i.e., how Project area riparian floodplain vegetation is currently functioning under existing natural flow conditions, and how floodplain plant communities will respond to various alternative Project operations.

Riparian Instream Flow Study objectives are to:

1. Synthesize the 1980s riparian vegetation study information and evaluate the applicability of the studies to the current Project;
2. Select riparian IFS intensive study sites in coordination with the Botanical Riparian Study 2012 field surveys and Instream Flow, Geomorphology, and Ice Processes Studies;
3. Map and measure riparian study reach riparian floodplain vegetation;
4. Develop a physical processes model−geomorphology and ice processes;
5. Develop a groundwater / surface water interaction model of shallow floodplain aquifer and riparian plant community relationships.
6. Develop a cottonwood and willow seed dispersal, hydrology, and Susitna River climate synchrony model;
7. Develop riparian floodplain plant community succession models and riparian vegetation-flow response guild models;
8. Develop scaling model of physical and riparian floodplain vegetation processes from intensive study reach to riverine / riparian process domains throughout the Project study area;
9. Provide riparian vegetation model output for analyzing the Project operational effects on riparian floodplain vegetation aquatic and riparian/wildlife habitat;
10. Coordinate groundwater / surface-water riparian floodplain vegetation modeling with evaluation of potential operational impacts to shallow groundwater well users (see Groundwater-Related Aquatic Habitat Study).

6.6.1.2. Riparian IFS Analytical Framework

Figure 6.5-3 depicts the overall analytical framework of the Instream Flow Studies commencing with the Reservoir Operations Model (ROM) that will be used to generate alternative operational scenarios under different hydroregimes. The ROM will provide the input data that will be used to predict hourly flow and water surface elevation data at multiple points downstream, taking into account accretion and flow attenuation. A series of biological and riverine process studies will be completed (other studies) to supplement the information collected in the 1980s as necessary to define reliable relationships between mainstem flow and riverine processes and biological resources. This will result in development of a series of flow sensitive models (e.g., models of selected anadromous and resident fish habitats by species and life stage, models to describe invertebrate habitats, temperature model, ice model, sediment transport model, turbidity model, large woody debris (LWD) recruitment model, riparian vegetation, others) that will be able to translate effects of alternative Project operations on the respective processes and biological resources. These resource and process effects will be location and habitat specific (e.g., responses are expected to be different in side sloughs versus mainstem versus side channel versus tributary delta versus riparian habitats) but there will also be a cumulative effect that translates throughout the entire length of the Susitna River. Different Project operations will likely affect different habitats and processes differently, both spatially and temporally. The habitat and process models will therefore be spatially discrete (e.g., by site, reach) and yet able to be integrated to allow for a holistic evaluation of each alternative operational scenario. This will allow for an Integrated Resource Analysis of separate operational scenarios that includes each resource element, the results of which can serve in a feedback capacity leading to new or modifications of existing scenarios.

The Riparian ISF Study is focused on integrating hydraulic models (HEC-RAS), geomorphic process models, ice processes models (ice formation, breakup and floodplain scour) and a groundwater / surface water interaction model, to generate a hydrogeomorphic modeling approach that will model the physical floodplain boundary conditions controlling the recruitment, establishment and maintenance of characteristic riparian floodplain plant communities. These models represent the core tools that will be used for assessing changes in riparian floodplain vegetation habitat and riparian plant community composition and spatial distribution under alternative Project operational scenarios.

6.6.2. Existing Information and Need for Additional Information

Information for the study area includes, but is not limited to, recent and historic aerial photography; riparian vegetation surveys and characterizations from recent and early 1980s studies; and riparian vegetation succession conceptual models developed from the 1980s data as part of the original Susitna Hydroelectric Project (SHP) Phase I vegetation mapping studies conducted along the Susitna River from the downstream end of Devils Canyon to Talkeetna, and the vegetation succession studies conducted in the Susitna River floodplain between Gold Creek, and the Deshka River (McKendrick et al. 1982, UAFAFES 1985). The riparian sites visited in the 1980s studies were resampled in 1992–1993 (Collins and Helm 1997, Helm and Collins 1997). Of primary importance to the Riparian Study is the previous vegetation mapping and successional dynamics studies by McKendrick et al. (1982), Collins and Helm (1997), and Helm and Collins (1997). These previous works will serve as a baseline for developing a stratified sampling protocol for both the Instream Flow Riparian and Botanical Riparian Study vegetation surveys. The riparian study modeling efforts will build upon the Collins and Helm (1997) riparian vegetation succession conceptual model (Figure 6.6-1)

Although substantial data and information concerning riparian vegetation were collected in the 1980s, those data are approximately 30 years old and therefore additional information needs to be collected to provide a contemporary understanding of the baseline riparian conditions existing in the Susitna River. Moreover, the previous studies (McKendrick et al. 1982; Collins and Helm 1997; Helm and Collins1997) were largely descriptive of riparian vegetation composition, structure and forest succession, and as such, they do not provide an analytical framework sufficient for assessing potential impacts to riparian vegetation that may result from Susitna-Watana Dam operations, nor do they provide the ability to model and develop potential flow mitigation measures. In addition, the configuration and proposed operations of the Project have changed and must be evaluated within the context of the existing environmental setting. This includes consideration of potential load following effects on riparian ecosystems downstream of the Susitna-Watana Dam (including the lower river reach, as appropriate). Therefore, additional riparian studies are necessary to adequately address the effects of potential Project operations on the riparian floodplain plant communities.

6.6.3. Study Area

The study area includes the Susitna River active valley that would be affected by the operation of the Project downstream of Watana Dam. The active valley is the geographic area that is flooded with a frequency and duration corresponding with current unregulated conditions. The formal Riparian ISF study area will be determined by the 2012 flow routing modeling determination of the hydraulic extent of Project operational influence from the Watana Dam site down river. For purposes of this study, the study area has been preliminarily divided into the following four river segments (Figure 6.5-1):

- Middle Reach Upper Segment (Above Devils Canyon) – Susitna River from Watana Dam site to upper end of Devils Canyon (RM 184 to RM 163)
- Middle Reach Middle Segment (Devils Canyon) — Susitna River from upper to lower end of Devils Canyon (RM 163 to RM 150)
- Middle Reach Lower Segment (Below Devils Canyon) – Susitna River extending from below Devils Canyon to confluence of Chulitna and Talkeetna rivers (three rivers) (RM 150 to RM 98.5); this reach may require further division;
- Lower Reach — Susitna River extending below Talkeetna River to mouth (RM 98.5 to RM 0)

6.6.4. Study Methods

The overarching goal of the Riparian Instream Flow Study is to assess the response of downriver riparian vegetation to Project operational flow regime and to provide recommendations for Project operations that will mitigate potential impacts to riparian vegetation. The study will first develop a process-based model of riparian vegetation succession and dynamics driven by riverine hydrogeomorphic processes. The modeling approach will use geomorphic, hydraulic, ice process and groundwater /surface water interaction models coupled with riparian vegetation succession models based upon vegetation surveys and previous Susitna River riparian forest research (Helm and Collins 1997). Objectives of the modeling approach are to: (1) quantify riparian vegetation physical process relationships under the natural flow regime, (2) assess potential impacts to riparian vegetation resulting from proposed Project operational flow regime, and (3) provide data for development of potential mitigation measures.

6.6.4.1. Synthesis of Historic Susitna River Riparian Vegetation Studies, Supporting Physical Process Investigations, and Other Hydro-Project Riparian Vegetation Investigations

The goal of this study element is to review and synthesize historic Susitna River riparian vegetation studies within the context of physical process investigations conducted in the 1980's including ice processes, sediment transport, surface water / groundwater and herbivory. Other North American hydro-project studies of downriver floodplain vegetation response to hydroregulation will be incorporated into the review to develop a current state-of-the-science review and analysis of potential Project operational flow effects on Susitna River riparian floodplain vegetation.

The objectives of this study task are to:

1. Conduct a critical review of previous Susitna River floodplain vegetation studies;
2. Place potential Susitna River Project operational effects within context of other studied hydroregulated rivers in North America;

Methodology

A literature review and analysis will be conducted including:

1. Historic Susitna River riparian floodplain research, and
2. Research concerning effects of hydroproject operational flow regimes on down river floodplain vegetation.

Work Products

1. Report chapter or technical memorandum with annotated bibliography appendix.

6.6.4.2. Riparian Process Domain Delineation and Intensive Study Reach Selection

Floodplain plant communities within mountain river corridors are dynamic in that channel processes annually disturb floodplain vegetation resulting in a characteristic patchwork of floodplain vegetation composition, structure and ages reflecting time since most recent vegetation disturbance (Naiman et al 1998). Vegetation disturbance can be defined as those processes that remove or impact plant communities and soils. Riverine floodplain vegetation disturbance types found within the Susitna River Project area corridor include: channel migration (erosion and depositional processes), ice processes (shearing impacts, flooding and freezing), herbivory (beaver and moose), wind, and, to an infrequent extent, fire.

Process domains define specific geographic areas in which various geomorphic processes govern habitat attributes and dynamics (Montgomery 1999).Temporal and spatial variability of channel processes can be therefore be classified and mapped throughout a channel network allowing characterization of riparian process domains that have similar suite of floodplain disturbance types and processes. The results of the classification will be used in selecting the riparian intensive study site reaches in coordination with the geomorphology, instream flow and ice processes studies.

Riparian study reaches will be selected that represent the suite of geomorphic and ice processes identified to occur within specific riverine riparian process domains. Together with the 2012 geomorphology study, ice process study and riparian botanical surveys we will develop the riparian process domain characterization which we will be used to locate six or more intensive riparian study reaches to subsample all identified riparian process domains.

The objectives of the riparian process domain delineation and intensive study reach selection are to:

1. develop a riparian process domain stratification of the Project study; and
2. select a sub-sample of intensive study reaches for physical and vegetation modeling.

6.6.4.2.1. Methodology

Riparian process domains will be delineated based upon the results of 2012 Geomorphology and Ice Processes studies, inspection of historic aerial photography used in the Geomorphology Study, and 2012 riparian field studies. The Geomorphology study team is delineating and classifying geomorphically similar river segments and reaches. The Lower River (RM 0 to RM 98.5), the Middle River (RM 98.5 to RM 184) and the Upper River to the Maclaren River confluence (RM 184 to RM 260) will be delineated into large-scale geomorphic river segments (a few to many miles) with relatively homogeneous characteristics, including channel width, entrenchment, ratio, sinuosity, slope, geology/bed material, single/multiple channel, braiding index and hydrology (inflow from major tributaries) for the purposes of stratifying the river into study segments (2012 Geomorphology Study). Channel reaches will be further classified based upon both aerial photographic analysis, and results of a geomorphic reach reconnaissance survey. The results of the 2012 Ice Processes study will be used to delineate river segments and reaches in which ice processes are directly interacting with floodplain vegetation such as river reach and segments where ice dam formation is noted to occur.

Together, the results of the 2012 Botanical Riparian Survey, geomorphology study channel classification and 2012 ice processes study, will be used to delineate riparian process domains have been identified to have similar physical floodplain vegetation disturbance processes.

6.6.4.2.2. Work Products

1. A technical memorandum describing the approach and methodology used to develop the riparian process domain map and intensive study reach selection process.
2. Map of Susitna River riparian process domains and intensive study sites.

6.6.4.3. Intensive Study Reach Riparian Vegetation Mapping and Measurement

The objectives of the intensive study reach riparian vegetation mapping and measurement are to:

1. characterize and map riparian floodplain plant community types relative to underlying alluvial terrain;
2. map and characterize floodplain plant recruitment and establishment patterns; and

3. characterize and measure plant community composition, abundance, structure, and age; and provide data for development of riparian vegetation succession and riparian vegetation –flow response guild models.

The riparian instream flow vegetation mapping and measurement approach builds upon those measures developed for the Botanical Riparian Study.

6.6.4.3.1. Methodology

6.6.4.3.1.1. Remote Sensing

Georeferenced historic, 1980s, and current aerial photography will be used to map riparian plant communities at all intensive study reaches. Mapping of all riparian plant communities will be conducted in the Botanical Riparian Study by digitizing individual plant community polygons in an ARCMAP GIS environment. Remote vegetation mapping will provide base maps for field sampling design, geomorphic reach analyses, and vegetation succession analysis. Figure 6.6-2 is an example of an intensive study reach with typical floodplain plant community types. Aerial photographic mapping results will be provided to the geomorphology team for use in geomorphic reach analyses and modeling.

6.6.4.3.1.2. Intensive Plots

Data will be recorded digitally in the field using a standardized data entry form designed to link directly to a relational database. Study sites will be at a minimum 500 square meters (5,382 square feet) (forested) and 50 square meters (538 square feet) (non-forest) circular plots, although shape may vary depending on the shape of the vegetation stand being sampled. We will follow methods provided by McKendrick et al. (1982), Collins and Helm (1997), and Helm and Collins (1997). Data attributes collected in the field will include, at a minimum:

1. Geo-referenced plot locations (less than 10-foot [3-meter] accuracy);
2. Vegetation cover by species in each of 7 height categories (0.0-0.1 meter [0.0-0.3 foot], 0.1-0.4 meter [0.3-1.3 feet], 0.4-1 meter [1.3-3.3 feet], 1-2 meters [3.3-6.6 feet], 2-4 meters [6.6-13.1 feet], 4-8 meters [13.1-26.2 feet], 8-16 meters [26.2-52.5 feet], and greater than 16 meters [52.5 feet]) based on transect point counts;
3. Ages (cross section cuttings or cores) and height of dominant woody plants;
4. Density by size class (< 0.4 meter [1.3 feet], 0.4-2 meters [1.3-6.6 feet], 2-4 meters [6.6-13.1 feet] and less than 4 centimeters [1.6 inches] DBH (diameter breast height, 1.4 meters [4.6 feet]); less than 4 meters [13.1 feet] and greater than 4 centimeters [1.6 inches] DBH; and greater then 4 meters [13.1 feet] and less than 4 centimeters [1.6 inches] DBH) or other size or structure classes for browse evaluations;
5. Crown dominance for each species;
6. General environmental variables, including physiography, geomorphic unit, surface form, soil drainage, soil moisture, elevation, aspect, and slope
7. Shallow pits for soil and hydrology characterization, including depth of water above or below ground surface, depth to saturated soil, and soil stratigraphic profiles;
8. Topographic elevation will be surveyed and tied in to reach bench mark;

9. Phenological attributes for selected plant species;
10. Vegetation structure and composition to identify each polygon's cover types and vegetation community;
11. Evidence of vegetation and soil ice scour; and
12. Wildlife sign such as browse marks, nests, dens, droppings, singing birds, carcasses, tracks, burrows.

6.6.4.3.1.3. Dendrochronology

Each mapped woody species plant community, including seedlings, will be aged to determine year of origin to be used in historic analysis of vegetation recruitment hydroregime characteristics and to model floodplain turnover / disturbance rates using standard Dendrochronologic techniques (Fritts 1977).

Tree and/or shrub dendrochronologic samples will be taken with either an increment borer or by cutting the shrub or sapling stem and taking a section for laboratory analysis. Increment cores (two per tree) will be collected from each tree. For each tree, floodplain sediment will be excavated to uncover the stem root collar and depth of sediment aggradation will be measured for further age estimation. A sample of tree seedlings for each dominant species will be excavated, heights measured, stems sectioned at the rood collar and annual rings measured under a dissecting microscope. A regression analysis will be conducted to assess the relationship between stem diameter and seedling height. The results will be used to add additional years to trees to account for height of core sample above the root collar.

Cores will be taken as close to the ground surface as possible, generally 12 inches (30 centimeters) above ground surface. Total height of tree core sample above the root collar will be calculated and used to estimate additional years to estimate tree year of origin. Twenty cottonwood seedlings were excavated from floodplain seedling plots and sectioned to determine height / age relationship for seedlings up to one meter in height. This relationship was used to add additional years to each tree core sample based upon core height above root collar and seedling height age relationship.

Increment cores will be mounted on pieces of 1 inch by 2 inch wood and sanded with variable grades of sand paper following standard methods described in Fritts 1976. Ring width measurements will be made, and annual years counted, for both the tree cores and stump sections using a dissecting microscope. Individual trees will be cross-dated, if possible, using standard methods (Fritts 1976).

6.6.4.3.1.4. Seedling Recruitment Plots

Floodplain plant species recruitment patterns will be mapped, and detailed survey sampling of seedlings conducted, to characterize spatial and temporal patterns of plant recruitment. Seedling recruitment (alluvial terrain location and elevation), composition, abundance, age, substrate characteristics and elevation will be sampled at each intensive study reach.

First, a reconnaissance level survey of the study reach will be conducted mapping locations (GPS) of seedling recruitment within various plant community successional stages (e.g., willow stage, alder stage, poplar stage, spruce stage). Second, seedling recruitment patches will be sampled using a stratified random survey for plot locations within each seedling patch. Seedling composition, abundance and height will be sampled using 2-meter (6.6-foot) square plots. At each plot two to three seedlings will be excavated and rooting depth measured. Seedlings will be aged at the root collar in the laboratory and annual rings measured to provide seedling age. Substrate texture and depth to cobbles will be described and measured by excavating to one meter in depth or to cobble refusal layer. Results of seedling mapping and characterization will be used to assess both groundwater and surface water relationships using 1-D / 2-D and MODLFOW modeling.

6.6.4.3.1.5. Habitat Plots

Riparian vegetation mapping and sampling will follow protocols developed in coordination with the Botanical Riparian Study plan. Riparian habitats in this study will be mapped to the Level IV of the Alaska Vegetation Classification (Viereck et al. 1992) with adjustments, as needed, for early successional riparian stages following Helm and Collins (1997). An Integrated Terrain Unit (ITU) mapping approach will be used. The ITU approach is based on methodology developed for various Ecological Land Surveys (ELS) done throughout the state of Alaska over the past 15 years (e.g., Jorgenson et al. 2003). All sampling will occur in the growing season months of June, July, and August.

Field sampling locations will be stratified across the study area using a gradient-directed sampling scheme (Austin and Heyligers 1989) to sample the range of ecological conditions across the sites. Intensive sampling will be conducted along toposequences (transects) placed across the floodplain surface. We will use high-resolution aerial or satellite imagery to pre-determine transect locations in the office. Along each transect, 7-10 plots will be sampled, each in a distinct vegetation type or spectral signature identifiable on aerial photographs. Sample plot locations will be intuitively controlled by the field crew leader, be placed in homogenous patches of vegetation (approximately 1.2-acre [0.5-hectare], minimum area), and ecotones will be avoided. Plots will be spaced adequately to cover the entire transect and to avoid "pseudoreplication" of plots within a single transect (i.e., sampling the same or very similar vegetation and soils within the same transect). Plot locations will be pinpricked on aerial photographs/satellite imagery, and coordinates (including approximate elevations) will be obtained with Global Positioning System (GPS) receivers (accuracy plus or minus 16.4 feet [5 meters]). At each plot (approximately 33-foot [10-meter] radius), geology, hydrology, soil stratigraphy, soil chemistry and vegetation structure and cover will be described or measured (see below). Digital photos will be taken at plot locations, including landscape and ground cover view, and photos of the soil pit face. All field data will be collected on a handheld tablet PC for easy digital upload upon return to the office.

Geologic and surface-form variables that will be recorded include physiography, geomorphic unit, slope, aspect, surface form, and height of microrelief. Sample plot elevations will be surveyed relative to the active channel (unvegetated channel) / active floodplain (vegetated floodplain surface) and water surface at the time of the survey. Hydrologic variables measured include depth of water above or below ground surface, depth to saturated soil, pH, and electrical conductivity (EC). Ground surface variables include percent frost boils and surface fragments. Water-quality measurements (pH and EC) will be made using portable meters that are calibrated daily with standard solutions.

General soils data will be collected from shallow soil plugs/pits (approximately 16-20 inches [40-50 centimeters] deep) or cut banks at each plot. When frozen ground is encountered at less than or equal to 20 inches (50 centimeters deep), we will continue to dig for approximately 4 inches (10 centimeters) into the frozen ground to confirm the presence of ice structure or other evidence of permafrost. General soils data collected at each plot will include depth of surface organic matter, cumulative thickness of all organic horizons, percent coarse fragments, cumulative thickness of loess, depth to upper boundary of coarse fragments (greater than 15 percent by volume), temperature (°C) at 20 inches (50 centimeters), presence of cryoturbation, presence of effervescence using a dilute acid solution, and depth of thaw. When water is not present, EC and pH will be measured from a saturated soil paste. Soil texture will be assessed by hand texturing, using a 2 milimeter (0.1 inch) mesh sieve to remove coarse fragments. A single simplified texture (i.e., loamy, sandy, ashy, organic) will be assigned to characterize the dominant texture in the top 16 inches (40 centimeters) at each plot for ecotype classification.

Vegetation composition and structure data will be measured semi-quantitatively for all vascular and dominant non-vascular plant species, and several categories of non-vascular plants, including percent *Spagnum* species; percent feathermoss, and percent combined *Cladonia*/*Cladina* species. If cover is less than 10 percent or more than 90 percent, then cover of each species or category will be visually estimated to the nearest 1 percent; for cover of 10-90 percent, cover will be estimated to the nearest 5 percent. Isolated individuals or species with very low cover will be assigned a cover value of 0.1 percent. In forested stands, DBH, age (using increment borer or thin cross-section), and height will be recorded for one to two representative dominant trees in each plot. Total cover of each plant growth form (e.g., tall shrub, dwarf shrub, lichens) will be estimated independently of the cover estimates for individual species. Data will be cross-checked to ensure that the summed cover of individual species within a growth form category was comparable to the total cover estimated for that growth form.

Ice process floodplain vegetation interactions will be mapped and characterized at each intensive study reach. Measurements will include type of evidence (soil disturbance, tree / shrub abrasion, whole scale plant community removal due to scour), and elevation surveyed. Mapped ice impact locations and elevation will be utilized in ice processes modeling of spatial extent and elevational zone characterization of ice / vegetation interactions at each study reach.

6.6.4.3.2. Work Products

Technical memorandum will be developed summarizing riparian floodplain plant community sampling results. Detailed descriptions of riparian floodplain species composition, abundance, structure, age and environmental parameters will be presented in figures and tables. Temporal and spatial seedling recruitment patterns will be characterized, mapped and modeled relative to groundwater / surface water.

6.6.4.4. Physical Process Modeling−Geomorphology and Ice Processes

Development of the study approach to physical processes study design, modeling, and methods will be coordinated closely with the Instream Flow, Geomorphology, Ice Processes, Botanical Riparian, and Groundwater-Related Habitat Study Teams. The integrated physical modeling approach is based upon: (1) physical modeling studies of select intensive study reaches representative of Project Area riverine process domains (Montgomery 1999), (2) HEC-RAS modeling of river stage / discharge and floodplain inundation at the intensive study reaches, (3) geomorphic reach analyses, (4) ice processes modeling, (5) groundwater / surface water interaction modeling of floodplain shallow alluvial aquifer and surface water relationships using MODFLOW, and (6) spatially explicit survey, mapping and analysis of the riparian floodplain plant communities' composition, structure, and location throughout the study area (Botanical Riparian Study).

6.6.4.4.1. Geomorphology and Ice Processes Modeling of Floodplain Vegetation Physical Template

The results of geomorphic and ice processes analyses and modeling will be integrated with the Riparian IFS modeling. The physical modeling results will be combined with the groundwater / surface water interactions modeling to produce an integrated physical model of floodplain plant community recruitment and establishment floodplain environmental conditions within the Project study area.

Project operations will likely store water during the snowmelt season (May through August), and release it during the winter (October through April, AEA 2011). This would alter the seasonal hydrology in the Susitna River downstream from the dam (lower flows from May through August and higher flows from October through April). In addition to these seasonal changes, the Project may be operated in a load-following mode. The Project will also store all incoming coarse sediments (sand, gravel, cobble, and boulders). Impacts of both of these processes will attenuate downstream from the location of the proposed dam, as the Susitna receives flow and sediment from unregulated tributaries.

These two Project-related impacts will alter the downstream surface water hydrology, relative balance between sediment supply and sediment transport capacity, ice-related processes in the winter, and surface water/groundwater interactions. All of these physical processes have the potential to alter existing riparian floodplain conditions downstream from the Project site. Assessment of potential Project-related impacts on riparian habitat will rely on information provided by the instream flow study (surface water flow routing during ice-free conditions), the geomorphology study (sediment supply/transport regime and channel morphology), ice processes study (surface water flow routing during the winter, ice growth and break up), groundwater study (surface water/groundwater interactions), and riparian instream flow botanical surveys.

The frequency, duration, and seasonal timing of high flows that inundate the floodplain, create new depositional alluvial surfaces and recharge the groundwater system, have been shown throughout North American rivers to be in synchrony with the cottonwood and willow species seasonal seed dispersal and seedling recruitment (Mahoney and Rood 1998). Project impacts to these riparian processes will be assessed using surface water flow routing during ice-free conditions provided by the instream flow study based on current channel morphology. The Project also has the potential to alter the downstream longitudinal profile of channel bed elevation (scour or deposition), and to alter the channel dimensions (width and depth). These potential changes will be assessed in the geomorphology study, and provided to the instream flow study for surface water flow routing. Potential impacts of the Project on cottonwood recruitment will be assessed based on current morphology and estimated morphology after 50 years of operation.

In a river that meanders through a wide valley, erosion on one side of the channel will be balanced by deposition on the other side as the river migrates laterally. Disturbance to riparian habitat on the eroding bank will be balanced by opportunities for recruitment on the point bar. This type of geomorphic process maintains the characteristic range of floodplain vegetation age classes contributing to the diversity of floodplain vegetation composition and structure (Naiman et al 1998). The rate of channel migration may be impacted by Project operations with additional potential impacts on the riparian community. Potential Project effects on lateral channel migration and reworking of the floodplain will be provided by the geomorphology study.

Impacts of ice-related processes on riparian habitat typically occur during breakup when scour in the river and adjacent floodplain may occur, and when the ice can scrape trees in the floodplain and leave them scarred (Prowse and Culp 2003). During breakup, ice accumulation in meander bends can force meltwater to bypass the bend and scour a meander cutoff (Prowse and Culp 2003). The Project will likely increase flows in the river during the winter, and ice may form at higher elevations. These potential effects may alter conditions during breakup and potentially impact floodplain vegetation at higher elevations than currently occurs. Potential effects of the Project on ice formation and breakup will be provided by the ice processes study.

Riparian floodplain vegetation relies to a large extent on groundwater as a water source (Naiman et al 1998). Floodplain groundwater depths have been demonstrated to control floodplain plant community composition, species richness and structure (Henszey et al 2004; Baird et al 2005; Mouw et al 2009; Naiman et al 1998). Project operations will alter on a seasonal basis the flows in the Susitna River and on a shorter time scale flows associated with potential load-following operations.

The altered surface water flow regime in the Susitna River may interact with the groundwater in the adjacent floodplain affecting shallow floodplain groundwater levels. Surface water hydrographs from the summer ice-free flow routing model (instream flow study) and the winter ice model (ice processes study) will be used as input for a MODFLOW model to assess impacts to the floodplain groundwater regime.

Spatial mapping of botanical communities on the floodplain will be performed as part of the riparian instream flow botanical communities. This mapping will be an important component of the groundwater model because different botanical species will have different root depths and different potential evapotranspiration rates. If the groundwater regime changes, the spatial composition of botanical species on the floodplain may potentially be impacted by Project operations.

Final details of the geomorphology and ice processes modeling elements of the Riparian IFS design will be developed during 2012 as results of the 2012 studies are obtained.

The objectives of the geomorphology and ice processes modeling are to:

1. develop an integrated model of the geomorphic and ice processes generated floodplain vegetation physical template;
2. integrate riparian floodplain vegetation studies with the geomorphology and ice processes modeling; and
3. integrate groundwater / surface water interactions model with geomorphology and ice processes model of floodplain vegetation physical conditions;

6.6.4.4.1.1. Methodology

The results of the geomorphology channel classification, geomorphic reach analyses, sediment transport modeling and ice processes modeling will be integrated during 2012. Upon development of the geomorphology and ice processes study plans, the riparian floodplain vegetation physical processes model integration approach will be developed.

6.6.4.4.1.2. Work Products

Integrated geomorphology, ice processes and riparian vegetation model for the Project area at both the intensive study reach and riparian process domain scales.

6.6.4.5. Physical Process Modeling−Groundwater / Surface Water Interaction Study

A physical model of groundwater / surface water interactions will be developed for four to six intensive study reaches to model groundwater /surface water relationships (GW/SW) with floodplain plant communities. Developing conceptual model and numerical representations of the GW/SW interactions, coupled with important processes in the unsaturated zone will help evaluate natural variability in the Susitna River riparian floodplain plant communities, and assesses how various Project operations may potentially result in alterations of floodplain plant community types, as well as improve the understanding of what controlled fluctuations of flow conditions would result in minimal riparian changes.

Regional and local groundwater flow systems are important to floodplain riparian vegetation (Figure 6.6-3). Seasonal river stage fluctuations generate transient groundwater and surface-water (GW/SW) interactions at a local scale under and adjacent to the river, including side channels, side sloughs and upland sloughs (Figures 6.5-2 and 6.6-3). A typical system representing several types of surface-water features is shown in the intensive study reach schematic (Figure 6.6-2). This plan view shows both the potential orientation of main stem and side channel surface water features, along with typical riparian floodplain plant community types found in the middle river segments of the Susitna River. A schematic cross-section of a typical profile across the river floodplain from main channel through floodplain, secondary channel and adjacent hillslope is shown in Figure 6.6-4. This figure depicts the relative relationships between surface-water stage levels, groundwater levels, land-surface elevations, and riparian floodplain plant community types.

Developing conceptual model and numerical representations of the GW/SW interactions, coupled with important processes in the unsaturated zone will help evaluate natural variability in the Susitna River riparian zones, and how various Project operations would potentially result in alterations of floodplain plant community types, as well as improve the understanding of what Project operational fluctuations of flow conditions would result in minimal riparian changes.

6.6.4.5.1. Methodology

We will use MODFLOW (USGS 2005), the most widely used groundwater model in the U.S. and worldwide. Additionally, we will utilize RIP-ET (riparian−evapotranspiration MODFLOW package; Maddock et al 2012) developed to help better represent plant transpiration processes in the unsaturated zone to more accurately calculate evapotranspiration, separating out plant transpiration from evaporation processes.

The field study will require the installation of groundwater wells and shallow piezometers, water level data collection equipment, general meteorological stations for ET calculations and riparian vegetation sensors to help measure sap flow rates to determine transpiration flux rates (Figures 6.6-2 and 6.6-4). Most of this data-collection infrastructure will be installed in early spring/summer 2013. Installation may take several months in 2013 for field crews to install the necessary data infrastructure.

Wells near the river will be drilled to a depth estimated to be 10 feet below winter low water levels in the adjacent mainstem channel. As wells are drilled further away from the river, the maximum depth will be determined by the drilling equipment, but should extend to depths of 40 feet in typical sands and gravels. All wells will use 1.5-inch PVC screened across the water table and completed to a depth of at least 10 feet below estimated low water table elevations. Each of these wells will have the horizontal and vertical locations surveyed to project accuracy standards used for water level measurements. Each well will have a steel protective outer casing, with locking covers. The top of locking cover, top of cap and a notch point will be surveyed on the lip of the PVC casing. As drilling crews complete wells, they will drill borings for the installation of temperature profile strings. The borings will be in close proximity to the wells, but no closer than four feet to any well.

Well sensors will be installed including pressure transducers at surface-water gauging stations and the central met station (Figure 6.6-2). Soil pits will be excavated to record soil characteristics, install unfrozen moisture content sensors, and log root-zone characteristics. Sensors will be protected in flexible steel conduit and buried where practical to help reduce animal damage. The installation goals will be to install all measurement systems within a three week time frame so data collection can begin approximately early July 2013.

Wells and water-level observation points will be resurveyed as needed in 2013 and will be resurveyed following snowmelt in 2014. Frost jacking of wells is a common issue in arctic conditions. Survey control network will be setup so that subsequent surveying efforts can be quickly done by a two-person survey crew.

The data collection period will begin early July 2013 and continue through September 2014. This will include the fall 2013 winter transition period, winter 2013/14 conditions, spring 2014 and summer 2014. Physical weather and climate conditions are not the same from year to year, so data collected during summer 2013 cannot be combined with data from 2014.

6.6.4.5.2. Work Products

1. A series of cross-section groundwater models for each study cross-section (Figure 6.6-2) that can be used for flow scenario testing.
2. A plan view 3D groundwater model for each study cross-section (Figure 6.6-2) that can be used for flow scenario testing.
3. A set of aquifer properties for geologic units represented in each study area, determined by inverse groundwater modeling of pressure responses between the Susitna River and adjacent groundwater systems(s).
4. Calibration and validation data sets for development of future GW/SW interaction and riparian vegetation-flow response guild models

6.6.4.6. Synchrony of Seed Dispersal, Hydrology and Local Susitna River Valley Climate

Pioneer riparian tree and shrub species in snowmelt-driven rivers are adapted to seasonal spring peak flows for seed dispersal and concordant near surface floodplain groundwater conditions for seedling recruitment and establishment (Figure 6.6-5; Braatne et al. 1996, Mahoney and Rood 1998, Mouw 2012). The timing of snowmelt-spring flows, and tree and shrub seedling release and dispersal, is critical to successful establishment and maintenance of riparian floodplain forests (Figure 6.6-6; Braatne et al 1996, Mahoney and Rood 1998, Scott et al 1997). An empirical model, the "Recruitment Box Model" that captures cottonwood and willow flow response and recruitment requirements has been successfully demonstrated on rivers throughout North America (Figure 6.6-6; Mahoney and Rood 1998, Rood et al 2003). The model describes how seasonal flow pattern, associated river stage (elevation), and flow ramping are necessary for successful cottonwood and willow seedling establishment (Figures 6.6-5 and 6.6-6). We will develop a recruitment box model for balsam poplar and select willow species for the Susitna River. Alterations of peak flows due to dam operations may result in a loss of spring peak flows and associated floodplain groundwater conditions necessary to the dispersal and establishment of riparian trees and shrubs.

The objectives of the seed dispersal, hydrology and climate synchrony study are to:

1. measure cottonwood and select willow species seed dispersal timing,
2. model local Susitna River valley climate relative to cottonwood and willow seed dispersal.
3. develop a recruitment box model of seed dispersal timing, river flow regime and cottonwood and willow establishment.

6.6.4.6.1. Methodology

To evaluate the natural synchrony of balsam poplar (*Populus balsamifera*), and select willow species (*Salix* spp.), seed release and Susitna River natural flow regime we will: (1) conduct a two year survey of seed release of balsam poplar and select willow species, and (2) develop a 'degree-day' model for the onset of seed release relative to local temperature conditions using methods developed by Stella et al. (2006). The results of this study will identify flow regime timing conditions necessary to support riparian forest recruitment and establishment on the Susitna River.

Four floodplain sites near existing meteorological stations in the Middle and Lower Susitna (Figure 6.6-7) will be selected for balsam poplar and select willow species seed release surveys. At each site twenty dominant female balsam poplar trees and willow shrubs will be surveyed weekly during the months of June, July and first two weeks of August, 2013-2014. Seed release will be measured during each survey by counting open catkins for each tree or shrub. Floodplain riparian plant community characteristics will be sampled for each floodplain seed dispersal survey site using the riparian vegetation sampling techniques described in Section 6.7.4.2. Tree data and seed release timing will be analyzed using protocols developed by Stella et al (2006). At all field sites local air temperature measurements will be collected from adjacent weather monitoring stations. A degree-day model using seed release observations and continuous temperature records from the monitoring stations will be developed (Stella et al 2006).

A recruitment box model (Figure 6.6-6; Mahoney and Rood 1998, Rood et al 2003) will be developed to evaluate the potential effects of various proposed spring operational flows on cottonwood and willow recruitment and establishment. Cottonwood and willow timing of seed release and dispersal relative to natural spring peak flows is a critical element necessary for the successful recruitment and establishment of cottonwood and willow on the Susitna River floodplain.

6.6.4.6.2. Work Products

1. Degree-day model of peak seed release window using seed release observations and continuous temperature records from each sample site.
2. Recruitment box model of cottonwood and select willow species.
3. Model of peak runoff / seed release temporal synchrony for operational flow guidelines.

6.6.4.7. Riparian Floodplain Vegetation Succession Models and Riparian Vegetation-Flow Response Guilds

6.6.4.7.1. Riparian Floodplain Vegetation Succession Models

Riparian floodplain vegetation succession model development will build upon previous studies of riparian plant community succession conducted in the Susitna and Talkeetna Rivers (Helm and Collins 1997, Mouw et al 2009). The number of riparian successional models to be developed will depend upon the final riparian Project area delineation as defined by the results of hydrologic assessment of the extent of operational flow changes throughout the Project study area from the Dam site to Cook Inlet. For example, the Helm and Collins (1997) model of riparian vegetation succession focused upon the middle river section and three rivers confluence segments of the Susitna (Figure 6.5-1). Once the extent of potential hydroregime change throughout the study area is assessed, and riparian Project area defined, the number of vegetation succession models incorporating the range of riparian vegetation types seen from the estuarine environment to the Dam site will be determined. For example, Sitka spruce (*Picea sitchensis)* and black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) occur within the lower estuarine reaches of the Susitna river, but these tree species do not extend geographically up river to the middle river segments. Therefore, riparian vegetation successional dynamics will vary throughout the Project study area and additional vegetation models will be developed to capture this variability once the extent of operational hydroregime influence is determined.

6.6.4.7.2. Riparian Vegetation-Flow Response Guilds

Criteria, metrics, indices will be developed for quantitatively describing riparian floodplain plant communities with varying natural flow regimes. These environmental flows will be used to develop riparian vegetation-flow response guilds (Merritt et al 2010). We will organize riparian plants into non-phylogenetic groupings of species with shared life history traits related to elements of the natural flow hydroregime, including: life history, reproductive strategy, morphology, adaptations to fluvial disturbance and adaptations to water availability (Merritt et al. 2010). Probabilistic response curves will be developed for select species, guilds and riparian plant community types. Development of a quantified relationship between individual riparian species, guilds and natural flow regime is the goal of the riparian Instream flow study. These riparian vegetation-flow response statistical relationships will enable a modeling of riparian vegetation response to operational flows and provide a defensible basis for recommended flow prescriptions necessary to protect riparian vegetation recruitment and establishment and riparian floodplain plant communities throughout the Project study area.

We will integrate the physical modeling and spatial mapping of riparian vegetation throughout the Project study area with results from the Botanical Riparian Study surveys to predict the extent and characteristics of riparian vegetation change under various simulated operational flows (Pearlstine et al. 1985).

The objectives of the intensive study reach riparian vegetation mapping and measurement are to

1. characterize and map riparian floodplain plant community types relative to underlying alluvial terrain;
2. map and characterize floodplain plant recruitment and establishment patterns;
3. characterize and measure plant community composition, abundance, structure, and age; and
4. provide data for development of riparian vegetation succession models.

6.6.4.7.3. Methodology

Results from the riparian sample surveys will be used to develop riparian floodplain vegetation successional models for the riparian plant community assemblages identified in the riparian botanical survey and intensive riparian instream flow surveys. Riparian vegetation successional models will be developed building on the models of Helm and Collins (1997) and Mouw (2009). Botanical riparian survey data and riparian IFS data will be analyzed and quantitative descriptions of plant community seral stages developed. The number of vegetation succession models is dependent upon the extent of the final riparian Project area as determined by 2012 hydrologic routing model study of the extent of Project operational influence in the Project area.

Riparian vegetation−flow response guilds (plant functional groups) will be developed from the Botanical and Riparian IFS survey data following protocols developed in Merritt et al. (2010). Riparian vegetation−flow response guilds will be used with the physical process modeling approach to analyze riparian vegetation flow regime relationships in the Project area and in modeling the potential impacts to riparian floodplain vegetation due to Project operations.

6.6.4.7.4. Work Products

1. Riparian vegetation successional models for all distinct riparian plant communities identified in the Botanical Riparian and Riparian IFS studies.
2. Development of riparian vegetation-flow response guilds from riparian botanical surveys and physical modeling.

6.6.4.8. Physical and Vegetation Model Scaling From Intensive Study Reach to Riverine / Riparian Process Domains

The results of the intensive reach study modeling will be scaled-up to the riverine / riparian process domains. The goal is to model both natural riparian flow-response guilds and natural

Susitna River physical process regimes as well as to evaluate Project operational impacts to floodplain vegetation and riparian ecosystem processes throughout the entire Project study area. Recent developments in GIS, LiDAR driven digital terrain models (DEMs), and geo-spatial analytical tools (ARCMAP, ESRI) has provided modelers the capacity to use the results of reach scale analyses to scale-up to larger geospatially defined areas or domains. Modeling riparian vegetation response, over a 185 mile Susitna River valley, to alterations of natural flow regimes, is inherently a geospatial analytical problem. Current state-of-the-art and science practice will be utilized to integrate modeling of physical processes (HEC-RAS, MODFLOW), riparian vegetation-flow response guilds with GIS geospatial analysis and display (ARCMAP, HEC-GEORAS).

The objectives of the intensive reach scaling model are to:

1. scale-up reach scale modeling results to riverine / riparian process domains;
2. assess potential impacts of Project operational flows on down river floodplain plant communities and ecosystem processes; and
3. provide input to Project operations.

6.6.4.8.1. Proposed Methodology

The results of the riparian process domain delineation, intensive study reach physical process modeling and riparian vegetation model development will be used with the results of the Botanical Riparian Survey Mapping of the Project area to model potential impacts to riparian floodplain vegetation throughout the Project area. Analyses will be conducted using ARCMAP and flow routing models to project operational flow regime changes throughout the Project area.

6.6.4.8.2. Work Products

Technical report describing the physical and vegetation modeling methods, results and GIS generated maps.

6.6.5. Consistency with Generally Accepted Scientific Practice

The proposed Riparian IFS, including methodologies for data collection, analysis, modeling, field schedules, and study durations, is consistent with generally accepted practice in the scientific community. The Riparian IFS is consistent with common approaches used for other FERC proceedings and references specific protocols and survey methodologies, as appropriate. Specifically, riparian vegetation mapping and measurement, the classification of riparian plant communities, and dendrochronologic techniques will follow standard methods generally accepted by the scientific community. A potential suite of groundwater and surface water models have been identified for integration with ice processes models that are widely used throughout the discipline. Current state-of-the-art and science practice will be utilized to integrate modeling of physical processes and riparian vegetation-flow response guilds with GIS geospatial analysis and display.

6.6.6. Schedule

The schedule for completing all components of the Riparian IFS is provided in Table 6.6-2. Licensing participants will have opportunities for study coordination through regularly scheduled meetings, reports and, as needed, technical subcommittee meetings. Reports will be prepared at the end of 2013 (Initial Study Report) and 2014 (Updated Study Report) for each of the study components. Licensing participants will have the opportunity to review and comment on these reports. Workgroup meetings are planned to occur on at least a quarterly basis, and workgroup subcommittees will meet or have teleconferences as needed.

6.6.7. Level of Effort and Cost

The Instream Flow Riparian Study is planned as a 2 year effort, with field sampling conducted spring through summers and fall of 2013-2014. Delivery of Initial Study Report in late 2013 and Updated Study Report in late 2014. Figure 6.5-7 depicts general work flow and key deliverable dates for the ISF and Riparian ISF Studies.

Riparian ISF Study elements and their estimated levels of effort include:

1. Spring/Summer 2013 field work investigating up to six intensive study reaches. Field effort will involve approximately a team of three ecologists one to two week per study site to map and sample riparian vegetation.
    - $250,000 – $310,000
2. Spring/Summer 2014 field work field work investigating up to six intensive study reaches. Field effort will involve approximately a team of three ecologists one to two week per study site to map and sample riparian vegetation.
    - $250,000 – $310,000
3. Modeling forest succession and physical processes (groundwater / surface water, hydraulic, ice processes, operational flow simulations).
    - $350,000 – $440,000
4. Statistical analyses and report development; meetings, presentations.
    - $350,000 – $440,000
5. Riparian groundwater/surface water interaction study.
    - Costs being developed

Total approximate effort/cost: $1.2-1.5 million (not including costs for riparian groundwater/surface water study instrumentation, field installation and monitoring, and MODFLOW modeling). Details and level of field effort will be based upon approved overall study objectives and design. Field surveys would be conducted for 30 to 40 days in each year, depending on the needs for additional ground-verification data. The Riparian IFS Study will involve extensive, office-based activities including remote sensing interpretation, physical modeling, vegetation modeling, statistical modeling, geospatial analyses and study report preparation.

The types and level of physical process modeling will be determined in coordination with the Instream Flow, Geomorphology, Ice Processes, Botanical Riparian, and Groundwater Related Habitat Study teams. Estimated study costs are subject to review and revision as additional details are developed.

6.6.8. Literature Cited

ABR (ABR, Inc.). 2011. Wildlife Data-Gap Analysis for the Proposed Susitna-Watana Hydroelectric Project. Draft Report, August 16, 2011. Prepared for The Alaska Energy Authority by ABR, Inc.–Environmental Research and Services, Fairbanks, Alaska. 114 pp.

AEA (Alaska Energy Authority). 2011. Pre-Application Document: Susitna-Watana Hydroelectric Project FERC Project No. 14241. December 2011. Prepared for the Federal Energy Regulatory Commission by the Alaska Energy Authority, Anchorage, Alaska.

Alaska Power Authority (APA). 1985. Before the Federal Energy Regulatory Commission: Draft amended application for license for major project—Susitna Hydroelectric Project. Volume 10, Exhibit E, Chapter 3: Fish, wildlife, and botanical resources.

Chapin, D.M., R.L. Beschta, and H.W. Shen. 2002. Relationships between flood frequencies and riparian plant communities in the upper Klamath Basin, Oregon. Journal of the American Water Resources Association 38: 603-617.

Chen, Fanghui, Hung Tao Shen, and Nimal C. Jayasundara. 2006. A one-dimensional comprehensive river ice model, Proceedings of the 18th IAHR International Symposium on Ice.

Collins, W.B., and D.J. Helm. 1997. Moose, Alces alces, habitat relative to riparian succession in the boreal forest, Susitna River, Alaska. Canadian Field-Naturalist 111: 567–574.

DHI Water and Environment. 2011. – MIKE 11.

DHI Water and Environment. 2011. MIKE 21 Flow Model, Hydrodynamic Module User Guide, 90 pp.

Fritts, H.C. 1976. Tree Rings and Climate. New York: Academic Press.

HDR Alaska. 2011. Susitna-Watana Hydroelectric Project; Railbelt Large Hydro; Aquatic Resources Data Gap Analysis. Prepared for Alaska Energy Authority, Anchorage, Alaska.

Harbough, A.W. 2005. MODFLOW-2005. The U.S. Geological Survey Modular Ground-Water Model−the Ground-Water Flow Process: U.S. Geological Survey Techniques and Methods 6-A16.

Helm, D.J., and W.B. Collins. 1997. Vegetation succession and disturbance on a boreal forest floodplain, Susitna River, Alaska. Canadian Field-Naturalist 111: 553–566.

Henszey, R.J., K. Pfeiffer, and J.R. Keough. 2004. Linking surface and ground-water levels to riparian grassland species along the Platte River in Central Nebraska, USA. Wetlands 24: 665-687.

Jorgenson, M. T., J.E. Roth, M. Emers, S.F. Schlentner, D.K. Swanson, E.R. Pullman, J.S. Mitchell, and A.A. Stickney. 2003. An ecological land survey in the Northeast Planning Area of the National Petroleum Reserve–Alaska, 2002. ABR, Inc., Fairbanks, AK. 128 pp.

Leclerc, M., Boudreault A., Bechara, J. A., and Corfa, G. 1995. Two-dimensional hydrodynamic modeling-a neglected tool in the instream flow incremental methodology. Transactions of the American Fisheries Society 124(5), 645-662.

Mahoney, J.M. and S.B. Rood. 1998. Stream flow requirements for cottonwood seedling recruitment−an integrative model. Wetlands 18: 634-645.

Maddock, Thomas, III, Baird, K.J., Hanson, R.T., Schmid, Wolfgang, and Ajami, Hoori. 2012. RIP-ET: A riparian evapotranspiration package for MODFLOW-2005: U.S. Geological Survey Techniques and Methods 6-A39, 76 p.

Mobile Boundary Hydraulics. 2010. Sedimentation in Stream Networks (HEC-6T), User Manual, March 16.

McKendrick, J.D., W. Collins, D. Helm, J. McMullen, and J. Koranda. 1982. Susitna Hydroelectric Project environmental studies Phase I final report, Subtask 7.12—Plant ecology studies. Report by University of Alaska, Agricultural Experiment Station, Palmer, for Alaska Power Authority, Anchorage. 124 pp. + appendix.

Montgomery, D. 1999. Process domains and the river continuum. Journal of the American Water Resources Association 35 (2): 397-410.

Mouw, J.B., J.A. Stanford, and P.B. Alaback. 2009. Influences of flooding and hyporheic exchange on floodplain plant richness and productivity. River Research and Applications 25: 929-945.

Mouw, J.E.B., J.L. Chaffin, D.C. Whited, F.R. Hauer, P.L. Matson and J.A. Stanford. 2012. Recruitment and successional dynamics diversify the shifting habitat mosaic of an Alaskan floodplain. River Research and Applications. Published online in Wiley Online Library (wileyonlinelibrary.com) DOI: 10: 10.1002/rra.2569.

Naiman, R.J., K.L. Fetherston, S.J. McKay, and J. Chen. 1998. Riparian forests. Chapter 12 In Naiman, R.J. and R.E. Bilby, River Ecology and Management, Lessons from the Coastal Pacific Northwest. Springer, New York.

Nakanishi, A.S., and Lilly, M.R. 1998. Estimate of aquifer properties by numerically simulating ground-water/surface-water interactions, Fort Wainwright, Alaska: U.S. Geological Survey Water-Resources Investigations Report 98-4088, 27 p.

Nelson, J.M., Y. Shimizu, H. Takebayashi, and R.R. McDonald, 2010. The international river interface cooperative: public domain software for river modeling, 2nd Joint Federal Interagency Conference, Las Vegas, June 27 to July 1.

Prowse, T.D. and J.M. Culp. 2003. Ice breakup: a neglected factor in river ecology. Canadian Journal of Civil Engineering 30: 128-144.

Rains, M.C., J.F. Mount, and E.W. Larsen. 2004. Simulated changes in shallow groundwater and vegetation distributions under different reservoir operations scenarios. Ecological Applications 14: 192-207.

Stella, J.C., J.J. Battles, B.K. Orr, and J.R. McBride. 2006. Synchrony of seed dispersal, hydrology and local climate in a semi-arid river reach in California. Ecosystems 9: 1200-1214.

UAFAFES (University of Alaska Fairbanks Agricultural and Forestry Experiment Station). 1985. Susitna Hydroelectric Project, riparian vegetation succession report. Draft report by University of Alaska–Fairbanks Agricultural and Forestry Experiment Pre-Application Document Susitna-Watana Hydroelectric Project Alaska Energy Authority FERC Project No. 14241 Page 4-263 December 2011 Station, Palmer, for Harza–Ebasco Susitna Joint Venture and Alaska Power Authority, Anchorage. 169 pp.

University of Alberta. 2002. River2D, two-dimensional depth averaged model of river hydrodynamics and fish habitat, introduction to depth averaged modeling and user's manual, September.

University of British Columbia. 2009. River2D – Morphology, R2DM, user manual for version 5.0, July.

U.S. Army Corps of Engineers. 2001. UNET One-dimensional unsteady flow through a full network of open channels, User's manual, CPD-66.

U.S. Army Corps of Engineers. 2010a. HEC-RAS River Analysis System User's Manual, CPD-68.

U.S. Army Corps of Engineers. 2010b. HEC-RAS River Analysis System Hydraulic Reference Manual, CPD-69.

U.S. Army Corps of Engineers. 2010c. HEC-RAS River Analysis System Applications Guide, CPD-70.

U.S. Army Corps of Engineers. 2010d. Adaptive Hydraulics User Manual Version 3.3. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

U.S. Bureau of Reclamation. 2008. SRH-2D version 2: Theory and User's Manual, Sedimentation and River Hydraulics – Two-Dimensional River Flow Modeling, November, 113 p.

U.S. Bureau of Reclamation. 2011. SRH-1D 2.8 User's Manual, Sedimentation and River Hydraulics – One Dimension, Version 2.8, 227p.

U.S. Geological Survey. 1997. Full Equations (FEQ) model for the solution of the full, dynamic equations of motion for one-dimensional unsteady flow in open channels and through control structures, Water-Resources Investigations Report 96–4240.

U.S. Geological Survey. 2005a. Multi-dimensional surface-water modeling system user's guide: U.S. Geological Survey Techniques and Methods, 6-B2, 136 p.

U.S. Geological Survey. 2005b. MODFLOW-2005, The U.S. Geological Survey modular ground-water model—the Ground-Water Flow Process: U.S. Geological Survey Techniques and Methods 6-A16, variously p.

U.S. Geological Survey. 2012. RIP-ET: A Riparian Evapotranspiration Package for MODFLOW-2005, Chapter 39 of Section A, Groundwater Book 6, Modeling Techniques.

U.S. National Weather Service. 1998. NWS FLDWAV model: theoretical description and user documentation, November 28.

Van Cleve, K.L., L.A. Viereck, and C.T. Dryness. 1996. State factor control of soils and forest succession along the Tanana River in interior Alaska, U.S.A. Arctic and Alpine Research 28: 388-400.

Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick. 1992. The Alaska Vegetation Classification. Pacific Northwest Research Station, U.S. Forest Service, Portland, OR. Gen. Tech. Rep. PNW-GTR-286. 278 pp.

Walker, L.R., and F.S. Chapin III. 1986. Physiological controls over seedling growth in primary succession on an Alaskan floodplain. Ecology 67: 1508-1523.

Walker, L.R., J.C. Zasada, and F.S. Chapin, III. 1986. The role of life history processes in primary succession on an Alaskan floodplain. Ecology 67: 1243-1253.

Winter, T.C. 2001. The concept of hydrologic landscapes. Journal of the American Water Resources Association 37: 335-349.

6.6.9. Tables

Table 6.6-1. Data collection parameters and associated sensors for a GWSW riparian monitoring system.

Process	Parameter	Sensor Type
Surface-water stage fluctuation	Pressure – calculated water levels	CSI CS 450 Pressure transducer
Groundwater stage fluctuation	Pressure – calculated water levels	CSI CS 450 Pressure transducer
Active-layer freezing and thawing	Resistance – calculated temperature	GWS-YSI Vertical thermistor strings
Active-layer freezing and thawing, Moisture availability	Unfrozen volumetric moisture content (%)	CSI CS616 Soil-moisture sensors
Evapotranspiration	Air temperature, Relative Humidity	CSI HC2S3 AT/RH sensor
Evapotranspiration	Wind Speed, Direction	RM Yound 05103 WS/WD sensor
Evapotranspiration	Radiation	CMP3 – Kipp & Zonen Pyranometer
Evapotranspiration	Soil-surface temperature	GWS-YSI Thermistor
Evapotranspiration	Precipitation	TI 525-US Tipping bucket rain gage
Plant transpiration	Delta-Temperature	DI – Dynagage and TDP sensors and sap flow algorithms

Notes:

1 Campbell Scientific Inc., CSI; Dynomax Inc., DI; Texas Instruments, TI, GW Scientific, GWS.

Table 6.6-2. Tentative Schedule for development of components of the riparian Instream Flow Study.

Activity	2012				2013				2014			
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4Q
Technical Consultant Selection	▲											
Refine and Finalize Study Plan		----▲	--▲---	-------								
Agency Licensing participant Site Visit			--▲									
Intensive Study Reaches Site Selection			--▲									
Review of 1980s Data and Information		-------	-------	------●								
Model Selection (1-D, HEC-GEORAS, mapping, etc.)			-------	---●								
Hydraulic Routing: data collection and reporting		-------	-------	------●	-------	-------	-------	-------	-------	-------	-------	-------
Hydraulic Routing: develop executable model				-------	-------	-------	-------	-------	-------	-------	-------	-------
Riparian Vegetation: Review literature and 1980s reports	-----	-----●			-------	-------	-------	-------	-------	-------	-------	-------
Riparian Vegetation: Field data collection (summer) (both years)		▲	▲		-------	---▲	---▲---	---▲	-------	--▲---	---▲--	▲
Riparian Vegetation Mapping (GIS, aerial videography, aerial photography)		-------	-------	-------	-------	-------	-------	-------				
Develop groundwater/surface flow models	------				------	------	------	------				
Study Reach Groundwater Sampling						------	------	------	------	------	------	
Hydraulic Model Integration and Calibration							------	------	------	------	----	
Riparian Habitat Modeling								-------	-------	-------		
Alternate Scenario Post-Processing								-------	-------	-------		
Reporting				●				●●				●●

6.6.10. Figures

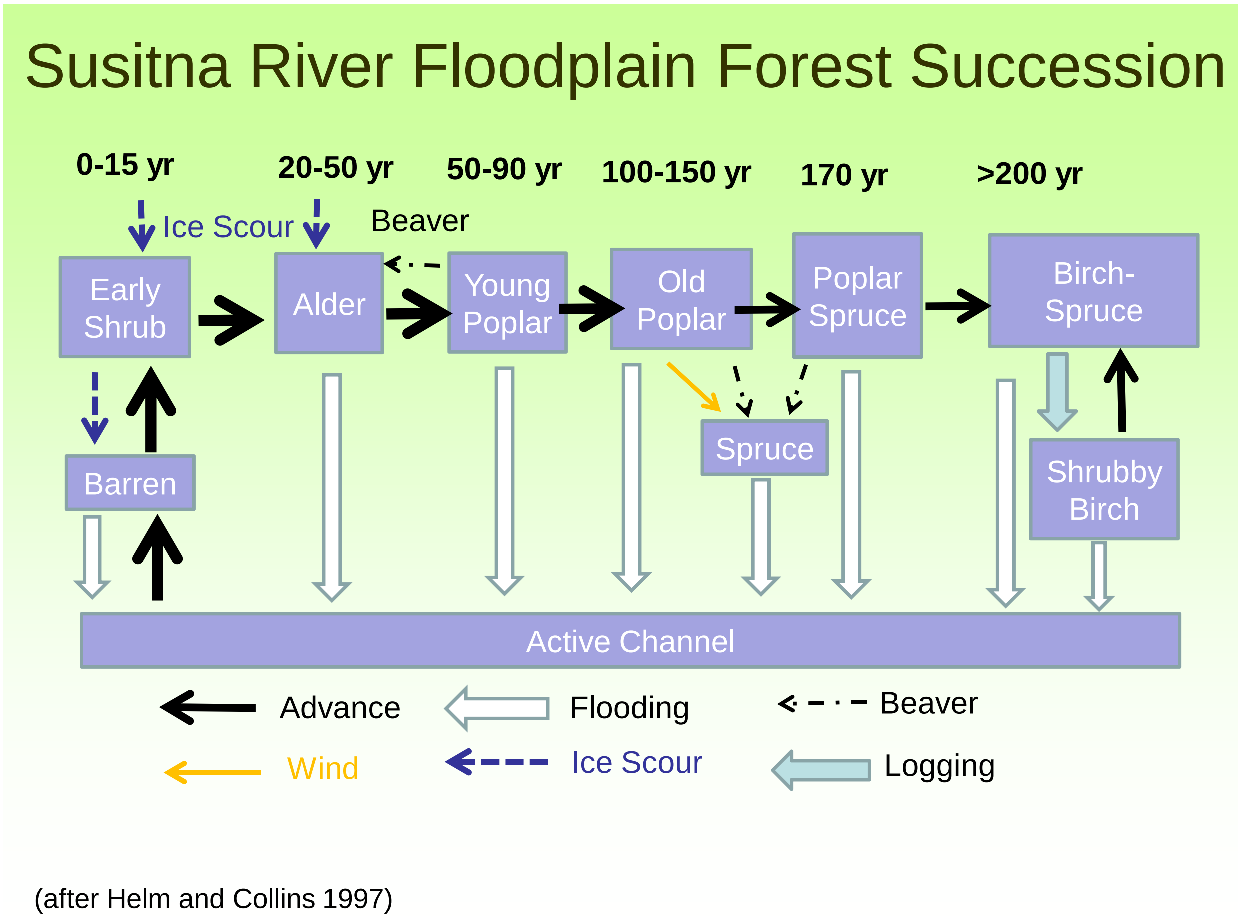


Figure 6.6-1. Helm and Collins (1997) Susitna River floodplain forest succession. Note: model depicts typical floodplain forests found in the Susitna River Middle river and three rivers confluence segments.

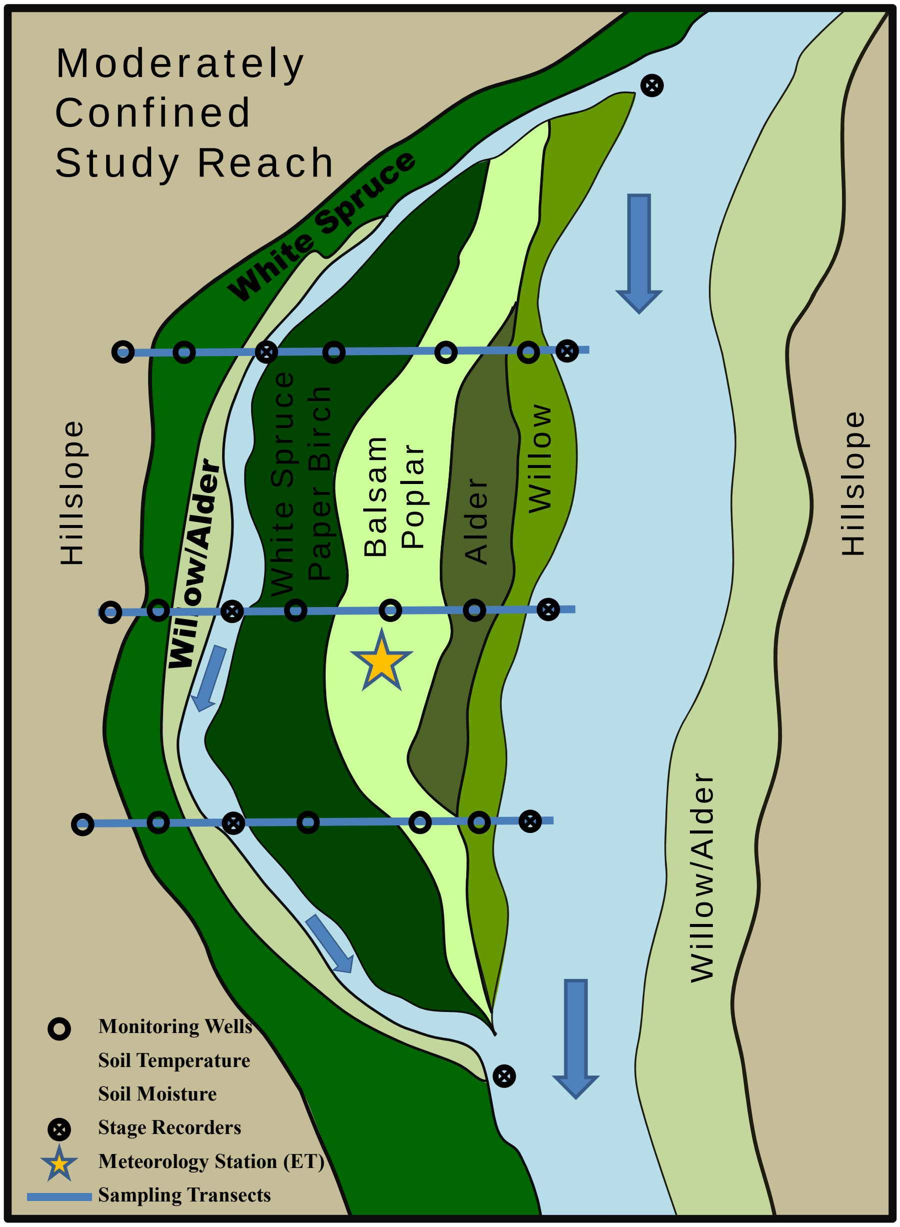


Figure 6.6-2. Typical intensive study reach groundwater / surface water study design illustrating monitoring well and stage recorder transect locations. Typical floodplain plant community types found in middle segment of Susitna River are shown.

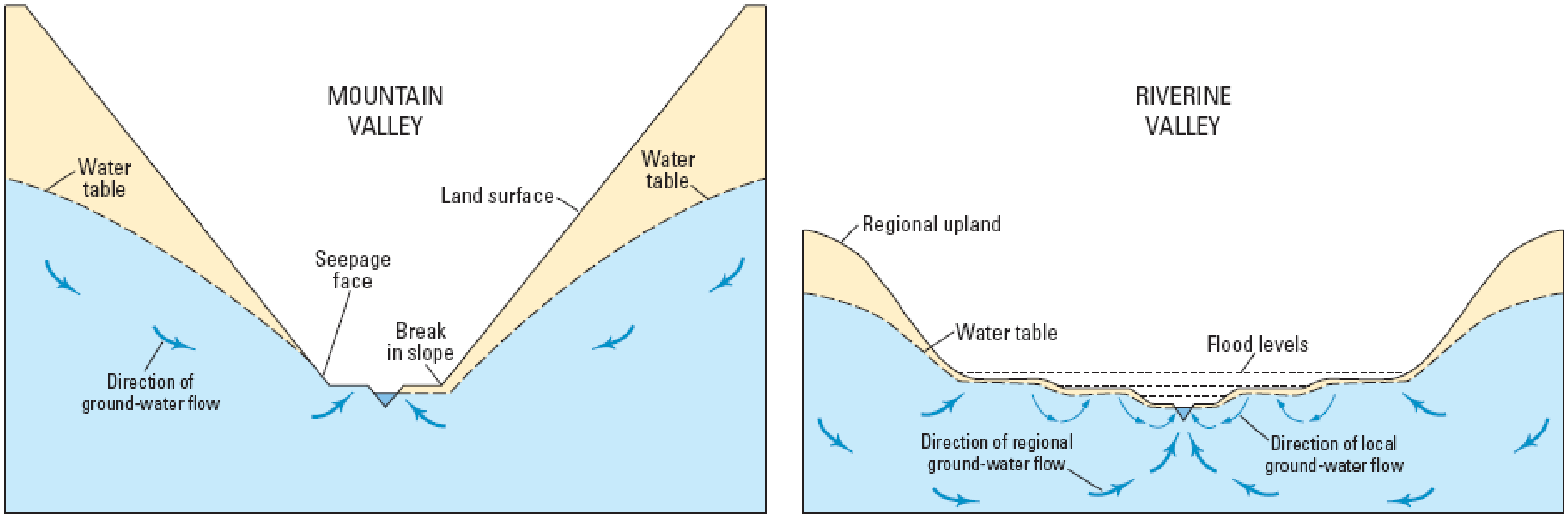
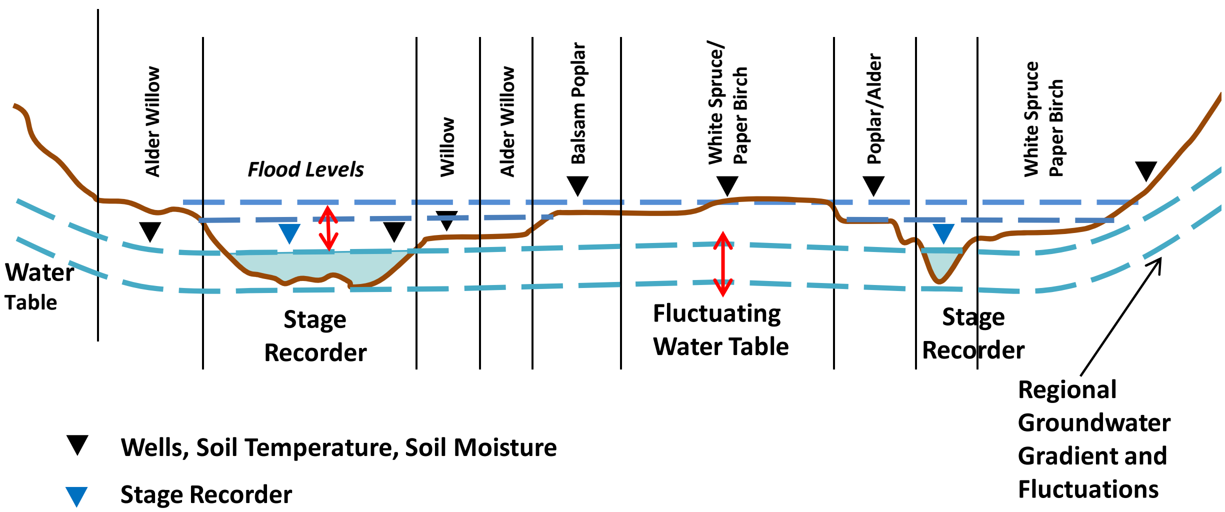


Figure 6.6-3. Riverine hydrologic landscape (Winter 2001)



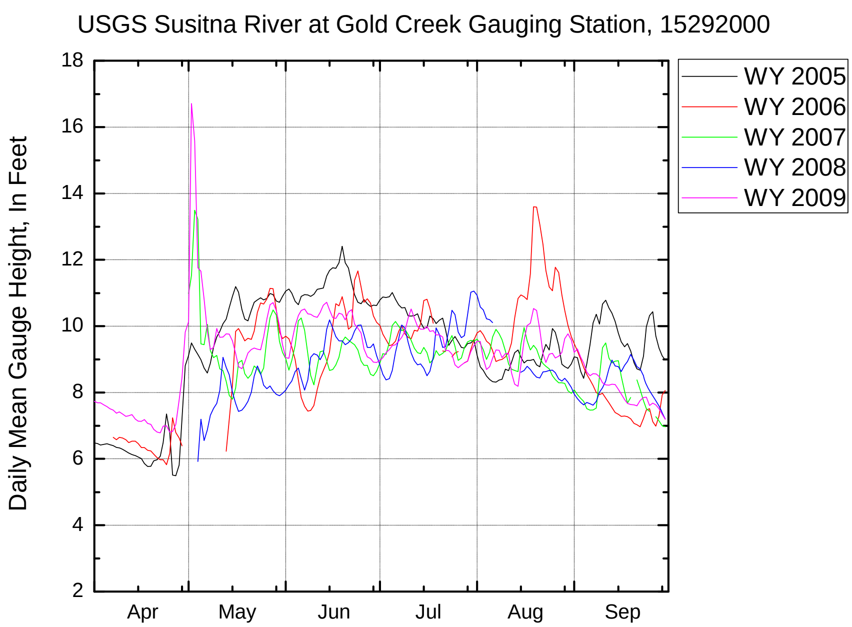


Figure 6.6-4. (A) Transect profile view of typical monitoring well and stage recorder locations looking down river. (B) Gold Creek Gauge Station, Susitna River April through September 2005-2009.

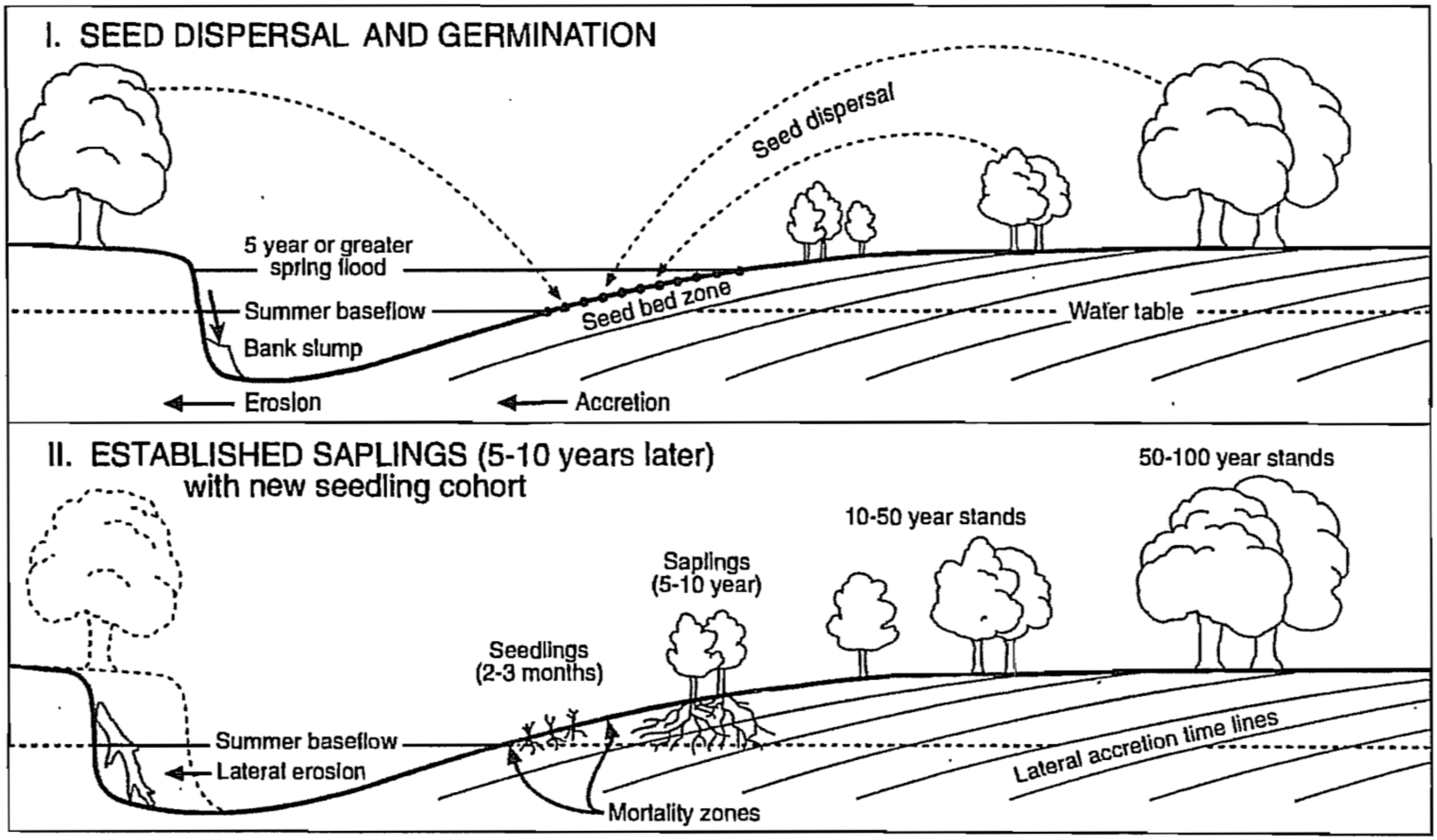


Figure 6.6-5. Cottonwood (*Populus*) life history stages: seed dispersal and germination, sapling to tree establishment. Cottonwood typically germinates on newly created bare mineral soils associate with lateral active channel margins and gravel bars. Note proximity of summer baseflow and floodplain water table (Braatne et al. 1996).

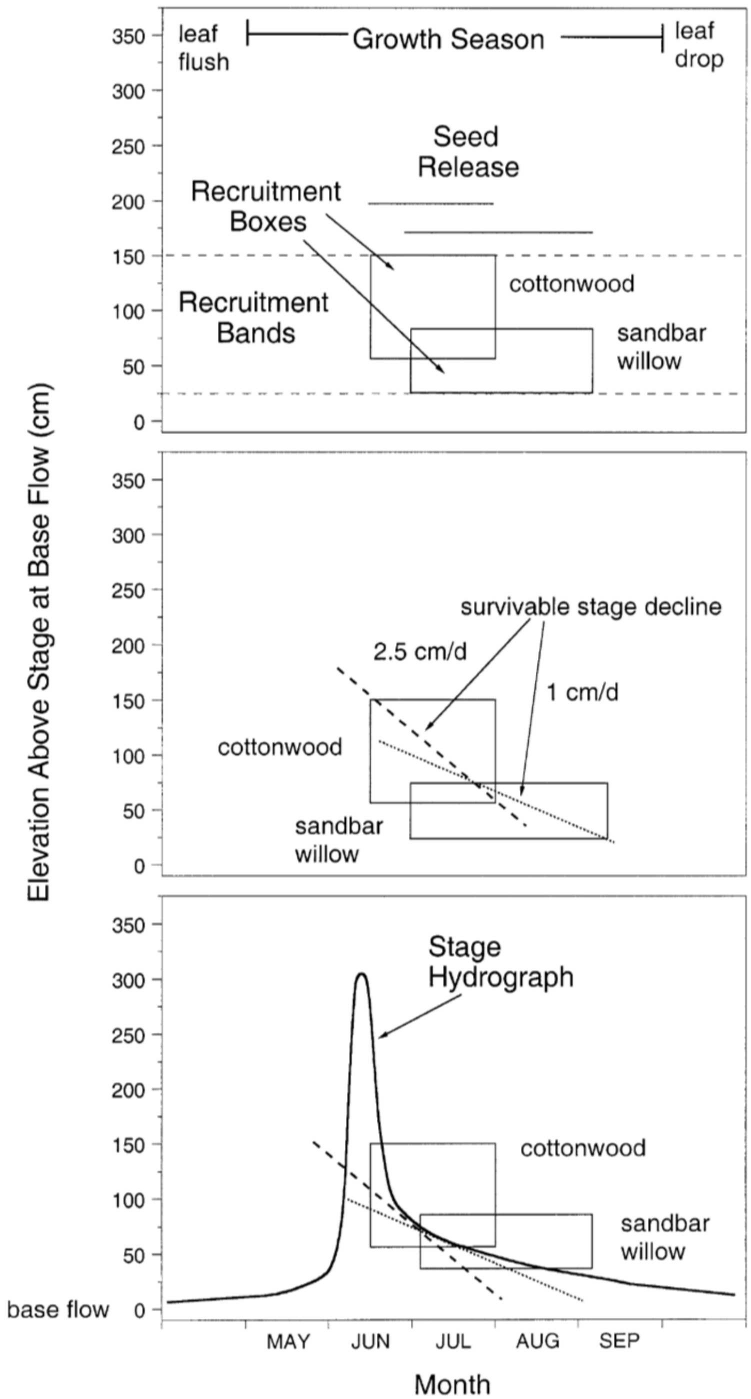


Figure 6.6-6. The riparian "Recruitment Box Model" describing seasonal flow pattern, associated river stage (elevation), and flow ramping necessary for successful cottonwood and willow seedling establishment (from Amlin and Rood 2002; Rood et al., 2005). Cottonwood species (*Populus deltoides*), willow species (*Salix exigua*). Stage hydrograph and seed release timing will vary by region, watershed, and plant species.

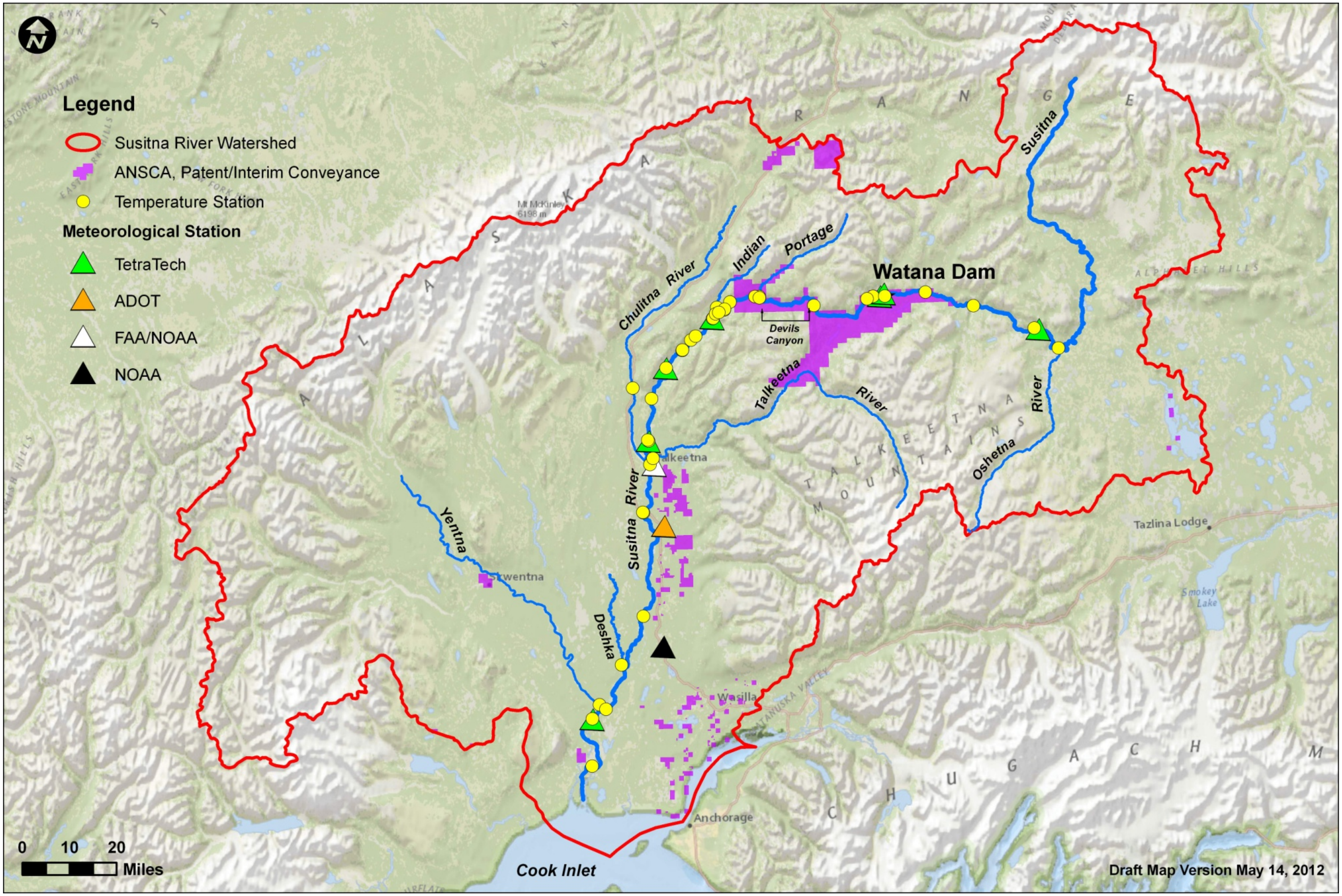


Figure 6.6-7. Project area meteorological station locations.

6.7. Attachments

ATTACHMENT 6-1. DOCUMENTATION OF CONSULTATION ON INSTREAM FLOW STUDY PLAN

ATTACHMENT 6-1

DOCUMENTATION OF CONSULTATION ON INSTREAM FLOW STUDY PLAN

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Anchorage Fish and Wildlife Field Office
605 West 4th Avenue, Room G-61
Anchorage, Alaska 99501-2249

IN REPLY REFER TO:
AFWFO

December 30, 2011

Ms. Sara Fisher-Goad
Executive Director
Alaska Energy Authority
813 W Northern Lights Blvd
Anchorage, AK 99503

Re: Proposed 2012 pre-licensing studies for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241-0000

Dear Ms. Fisher-Goad:

The U.S. Fish and Wildlife Service (Service) is responding to the Alaska Energy Authority's (AEA) verbal request for recommendations on pre-licensing studies in 2012 for the Susitna-Watana Hydroelectric Project. The Service has previously provided some verbal comments at project planning meetings and in conversations with AEA project and consulting staff. The Service will be better able to provide complete comments (as part of the National Environmental Policy Act scoping process), after reviewing more thorough descriptions of the proposed project and project operations anticipated in the Preliminary Application Document (PAD). The following comments and study recommendations for 2012 are considered preliminary until we review the PAD and fully understand the scope of the proposed project.

We recognize that the newly proposed Susitna-Watana project is different than the proposed Su-hydro project of the 1980s. Differences in: 1) the two proposed project designs; 2) the past and present study methodologies (due to evolving scientific technologies); and 3) the scientific rigor of previous investigations, may limit the applicability of study results from the 1980s. In many instances, the 1980s studies were limited in spatial and temporal scope, and the methodologies may have been limited, outdated, non-replicable, or lacking in resolution, potentially making them incomparable to present technologies. For these reasons, the Service is concerned about the applicability of the 1980s Su-hydro studies relative to the proposed Susitna-Watana project.

The Service appreciates that AEA recently had the 1980s studies synthesized for identification of data gaps. A reasonable next step is to review the study results for appropriateness and applicability to the newly proposed Susitna-Watana project. Specifically, results from the 1980s studies should be reviewed for statistical validity.

The Service and other resource agencies have previously expressed concerns about the assumptions, relevance, and applicability of 30-year old studies conducted for a different project proposal, in a dynamic basin such as the Susitna River. We have also raised concerns over the lack of proposed studies in the upper and lower reaches (as defined by AEA) of the Susitna River for both the 1980s and in the proposed Susitna-Watana project.

To begin assessing potential impacts to fish and wildlife resources in the project area, the Service recommends the following reconnaissance level studies and reviews for 2012:

- Biometric review of biologic and hydrologic study results from the 1980s.
  Rationale: To assess the statistical validity of the 1980s Su-hydro study results for applicability to proposed studies for the Susitna-Watana project.

- Establish cross-sections for the lower reach, determine the hydraulic connection between the Susitna River and sloughs and off-channel habitats, and incorporate them into the hydrologic model.
  Rationale: To quantify and evaluate the effect of project operations on the lower reach (as climate and other conditions change within the watershed)

- Monitor flow and sediment in the Chulitna and Talkeetna Rivers, and in Gold Creek.
  Rationale: To quantify and evaluate individual tributary flow contributions and sediment loads and assess the potential effect of project operations on lower reach habitats and functions.

- Quantify distribution of fish assemblages relative to available habitat and stream temperature at channel, reach, and spatial scales (as defined by Torgersen et al. 1999).
  Rationale: To assess and quantify fish assemblages relative to available habitats that may be affected by proposed project operations; there are approximately 20 fish species in the Susitna River and little information known about their distribution.

- Collect longitudinal thermal imaging data in all Susitna River study reaches
  Rationale: Information is needed to assess and quantify important aquatic habitats (e.g., thermal refugia) that may be affected by proposed project operations

The Service considers these minimum recommendations necessary to establish a framework to identify future applicable studies throughout the licensing process. When we review the PAD we will likely revise our recommendations to reflect the integration we would like to see in the 2012 studies.

Thank you for the opportunity to provide comments on pre-licensing studies for this proposed project. We look forward to continued coordination with AEA regarding resource appropriate studies. If you have any questions regarding these comments, please contact project biologist, Mike Buntjer at (907) 271-3053, or by email at michael_buntjer@fws.gov.

Sincerely,

Acting For:

Ann G. Rappoport
Field Supervisor

cc: S. Walker, NOAA, susan.walker@noaa.gov
E. Rothwell, NOAA, eric.rothwell@noaa.gov
T. Meyer, NOAA, tom.meyer@noaa.gov
E. Waters, BLM, ewaters@ak.blm.gov
B. Maclean, BLM, bmaclean@blm.gov
C. Thomas, NPS, cassie_thomas@nps.gov
M. LaCroix, EPA, LaCroix.Matthew@epamail.epa.gov
J. Klein, ADF&G, joe.klein@alaska.gov
M. Daigneault, ADF&G, michael.daigneault@alaska.gov
G. Prokosch, ADNR, gary.prokosch@alaska.gov
D. Meyer, USGS, dfmeyer@usgs.gov
K. Lord, DOI, ken.lord@exchange.sol.doi.gov
B. McGregor, AEA, bmcgregor@aidea.org
W. Dyok, AEA, wdyok@aidea.org
B. Long, issues320@hotmail.com
C. Smith, TNC, corinne_smith@TNC.ORG
J. Konigsberg, HRC, jan@hydroreform.org
K. Strailey, ACE, kaarle@akcenter.org
M. Coumbe, ACA, mike@akvoice.org
P. Lavin, NWF, lavin@nwf.org
R. Wilson, Alaska Ratepayers, richwilsonak@gmail.com

References:

Draft Susitna-Watana Hydroelectric Project Aquatic Resources Data Gap Analysis. 2011. Prepared for the Alaska Energy Authority. Prepared by HDR Alaska, Inc., Anchorage, AK.

Grant G. E., J. C. Schmidt, S. L. Lewis. 2003. A geological framework for interpreting downstream effects of dams on rivers. Water science and application 7.

Fausch, K. D., C. E. Torgersen. C. V. Baxter. H. W. Li. 2002. Landscapes to Riverscapes: Bridging the Gap between research and conservation of stream fishes. American Institute of Biological Sciences.

Schlosser, I. J. 1991. Stream Fish Ecology: A Landscape Perspective. BioScience Vol. 41 No. 10
Torgersen, C. E., C.V. Baxter, H. W. Li, and B. A. McIntosh. 2006. Landscape influences on longitudinal patterns of river fishes: spatially continuous analysis of fish-habitat relationships. American Fisheries Society Symposium 48: 473-492.

Torgersen, C. E., R. N. Faux, B. A. McIntosh, N. J. Poage, D. J. Norton. 2001. Airborne thermal remote sensing for water temperature assessment in rivers and streams. Remote Sensing of Environment 76; 386-398.

Torgersen. C. E., D. M. Price, H. W. Li, and B. A. McIntosh. 1999. Multi-scale thermal refugia and stream habitat associations of Chinook salmon in Northeastern Oregon. Ecological Applications 9(1), pp. 301-319.

Water Quality and Sediment Data Gap Analysis. 2011. Prepared for the Alaska Energy Authority. Prepared by URS, Tetra Tech, Inc., and Arctic Hydrologic Consultants, Anchorage, AK.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Anchorage Fish and Wildlife Field Office
605 West 4th Avenue, Room G-61
Anchorage, Alaska 99501-2249

IN REPLY REFER TO:
AFWFO

February 10, 2012

Ms. Sara Fisher-Goad
Executive Director
Alaska Energy Authority
813 W Northern Lights Blvd
Anchorage, AK 99503

Re: 2012 pre-licensing draft study plans for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241-0000

Dear Ms. Fisher-Goad:

The U.S. Fish and Wildlife Service (Service) is responding to the Alaska Energy Authority's (AEA) request for comments on 2012 pre-licensing draft study plans for the Susitna-Watana Hydroelectric Project. The Service provided some initial comments on the draft study plans during the work group meetings January 24-26, 2012, and had anticipated providing additional comments after receiving revised and more thorough descriptions of the proposed studies. Since that meeting, we have conducted an initial review of the Instream Flow, Aquatic Resource, Water Resource, and Eagle and Raptor Nest draft 2012 study plans provided at the January 24-26, 2012, meetings. Due to the short turnaround time requested for feedback (11 business days) on the study plans and their ongoing evolution, our comments should be consider cursory. The following represents our overall issues and concerns with the study plans and the enclosure provides a more detailed accounting of our comments and recommendations for each specific study plan.

Expanded Study Framework and Timeframe: The Service and other resource agencies have frequently expressed concerns about the limited temporal and spatial scale, and limited timeframe, for proposed studies in a dynamic basin such as the Susitna River. We have also raised concerns over the lack of proposed studies in the lower reaches (as defined by AEA) of the Susitna River for the proposed Susitna-Watana project. As part of the hierarchical framework, an ecologically meaningful space-timing scale should be identified related to project studies. As the spatial scale of studies increases, the time scale of important processes such as ice, sedimentation, and channel formation also increases, because they operate at slower rates, time lags increase, and indirect effects become increasingly important. Studies related to these dynamic fish habitat forming processes need to be adequate (i.e., 5 years or more) to begin to understand mechanistic linkages (Wiens et al 1986; Wiens 2007). For this purpose, the Service recommends conducting fish habitat forming process studies on the minimum temporal scale of 5 years. This temporal scale equates to the typical life cycle of Chinook salmon, an Alaska Department of Fish and Game designated stock of concern.

To address these concerns, the Service expects that the 2012 studies and future project-related studies will be conducted on a hierarchical framework (Urban et al 1987; Frissell et al 1986) at a variety of scales including meso-habitat, reach, and basin wide. The Service also expects that the 2012 studies will not only help fill data gaps identified in the Preliminary Application Document (PAD), but will also be integrated between each other and with future project-related studies. This framework and integration is necessary to understand existing conditions and predicted changes to fish habitat in relation to changes in physical processes from proposed regulated flows. We recommend you establish a schedule for analysis of data obtained in 2012 and a framework for how to incorporate the 2012 data into 2013-2014 study plans. This is necessary for resource agencies to adequately assess potential project impacts to Alaska's fish and wildlife resources.

Winter Flow Regimes: At the January 24-26 work group meetings, and in the PAD, winter operations were described as load-following with flows ranging from 3,000 to 10,000 cfs in a 24-hour period. Regulated flows, including load-following operation, result in substantial changes to the natural hydrograph of a river. Dam construction and operation globally has resulted in adverse effects to anadromous and resident fish, macroinvertebrates, and their habitats. The Service is particularly concerned with the lack of study focus on Susitna River winter flows under natural and proposed flow operations. We recommend that winter base flows be assessed beginning in 2012 under the Instream Flow 2012 Study Planning, Water Resources Study Planning, and in the Aquatic Resources Study Planning. During colder winter months, glacial river base flows, such as those in the Susitna River, are derived entirely from groundwater inputs resulting in reduced habitat availability. We recommend assessing base flows as they relate to mainstem winter habitats (including adult spawning and juvenile fish overwintering locations, and the potential for stranding or increased mortality or condition related to changes in flow and water temperature), water quality conditions, ice-processes, and habitat and geomorphic processes in the Susitna River under current conditions and underthe proposed operation.

Temperature: In our December 30, 2011, letter we recommended thermal imagery (Torgerson et al. 1999) be conducted in 2012 throughout the Susitna River mainstem to identify important thermal habitats that may be utilized for spawning, refugia, or as overwintering areas. It is important to characterize the Susitna River water temperature profile as it relates to habitat because the proposed dam is expected to significantly alter the water temperatures downstream of the dam. Please review this letter as a reference for this study, as well as other Service recommendations.

Modeling Design: There is currently a lack of information in the draft study plans related to overall modeling approaches that will be used for the Susitna-Watana project. When identifying instream flow model(s) the purpose and assumptions must be compared to Water Resources and Aquatic Resources study objectives. Model assumptions and model inputs need to be clearly stated and available for review. Spatial pattern should be one of the independent variables in the model analysis. At a minimum, we recommend using 2D hydrodynamic model(s) at a mesohabitat, reach, and basin wide scale (Crowder and Diplas 2000). We specifically recommend a 2D model be included to predict physical processes to spatially represent variation in input variables, and how those variables change temporally and spatially under differing flows. Selected model(s) should also include a sensitivity analysis (Turner et al. 2001). This information is critical to the general project understanding of existing ecological spatial patterns, and predicted spatial patterns under proposed regulated flows from the Susitna-Watana dam.

Mercury: Since the January meetings, it was brought to our attention that fish mercury concentrations frequently increase after impoundment of a reservoir, particularly boreal reservoirs. Soil flooding releases organic matter and nutrients, providing food to bacterial communities that methylate inorganic mercury. Methylation and bioaccumulation are the primary pathways for mercury accumulation in fish (Therriault, 1998). Although not identified in the 2012 draft studies, future studies should include pre- and post-impoundment mercury concentration studies.

Thank you for the opportunity to provide comments on the 2012 draft study plans for this proposed project. We look forward to continued coordination with AEA regarding resource appropriate studies. If you have any questions regarding these comments, please contact project biologist, Mike Buntjer at (907) 271-3053, or by email at michael_buntjer@fws.gov.

Sincerely,

Ann G. Rappoport
Field Supervisor

cc: S. Walker, NOAA, susan.walker@noaa.gov
E. Rothwell, NOAA, eric.rothwell@noaa.gov
T. Meyer, NOAA, tom.meyer@noaa.gov
E. Waters, BLM, ewaters@ak.blm.gov
B. Maclean, BLM, bmaclean@blm.gov
C. Thomas, NPS, cassie_thomas@nps.gov
M. LaCroix, EPA, LaCroix.Matthew@epamail.epa.gov
J. Klein, ADF&G, joe.klein@alaska.gov
M. Daigneault, ADF&G, michael.daigneault@alaska.gov
G. Prokosch, ADNR, gary.prokosch@alaska.gov
D. Meyer, USGS, dfmeyer@usgs.gov
K. Lord, DOI, ken.lord@exchange.sol.doi.gov

B. McGregor, AEA, bmcgregor@aidea.org
W. Dyok, AEA, wdyok@aidea.org
B. Long, issues320@hotmail.com
C. Smith, TNC, corinne_smith@TNC.ORG
J. Konigsberg, HRC, jan@hydroreform.org
L. Yanes, ACE, louisa@akcenter.org
A. Moderow, ACA, andy@akvoice.org
P. Lavin, NWF, lavin@nwf.org
R. Wilson, Alaska Ratepayers, richwilsonak@gmail.com

References:

Crowder, D.W. and P. Diplas. 2000. Using two-dimensional hydrodynamic models at scales of ecological importance. Journal of Hydrology 230:172-191.

Frissell, C A., W. J. Liss, C. E. Warren, and M. D. Hurley. 1986. A hierarchical framework for stream habitat classification; viewing steams in a watershed context. Environmental Management 10: 199-214.

Therriault, T.W., D.C. Schneider. 1998. Predicting change in fish mercury concentrations following reservoir impoundment. Environmental Pollution 101: 33-42.

Torgersen. C. E., D. M. Price, H. W. Li, and B. A. McIntosh. 1999. Multi-scale thermal refugia and stream habitat associations of Chinook salmon in Northeastern Oregon. Ecological Applications 9(1), pp. 301-319.

Turner, M.G., R.H. Gardner, and R.V. O'Neill. 2001. Landscape Ecology in Theory and Practice. Springer-Verlag, New York. Chapter 3, Introduction to Models.

Urban, D. L. R. V. O'Neill, and H. H. Shugart, Jr. 1987. Landscape Ecology.

Wiens, J. A. 2007. Spatial Scaling in Ecology. Functional Ecology, Volume 3, Number 4. (1989), pp. 385-397.

Wiens, J. A., Addicott, J. F., T. J. Case, and J. Diamond. 1986. Community Ecology. Overview: The importance of spatial and temporal scale in ecological investigations.

Enclosure

The following comments and recommendations are based on our review of the 2012 pre-licensing draft study plans for the Susitna-Watana Hydroelectric Project provided at the January 24-26, 2012, work group meetings.

Synthesis of Existing Fish Population Data (F-S1)

Recommend including information on seasonal distribution and abundance of anadromous and resident fish species among riverine habitat types and river reaches. As part of the spawning and incubation period for resident and anadromous species, studies need to include fry emergence periods and time (of day) information to determine potential impacts from fluctuating winter/spring flows. Potential issues include stranding of fish (by life stage and species) and downstream displacement relative to potential ramp rates. This study needs to integrate with instream flow and geomorphic studies to look at effects of daily flow fluctuations, particularly in winter, in the middle and lower river reaches.

For clarity, we recommend referring to river "reaches" as defined in the PAD rather than river "segments."

Fish persistence should be evaluated relative to spatial and temporal availability of fish habitat under existing and proposed flows. The Service recommends fish habitat studies be developed concurrent with the water resource studies to interface and characterize fish habitat as it relates to physical (hydrologic, sedimentation, and geomorphic) processes. Fish habitat metrics should be developed and integrated with modeling efforts related to physical processes and fish presence.

Chinook Salmon Presence above Devil's Canyon Study (F-S4)

Chinook salmon presence above Devil's Canyon study should include an upstream and downstream fish passage component. This 2012 study should include fish passage relative to all life stages of Chinook salmon. There is the potential to include Dolly Varden and Humpback whitefish pending results of an otolith/anadromy analysis by the Service for these species.

The Service supports the genetic component of the study (F-S4) which is necessary to determine whether the Chinook salmon meta-population in the vicinity of the proposed dam is a distinct population.

Wetland Mapping Study (B-S3)

The draft wetland study states that the methods used will be consistent with guidance in the Alaska Regional Supplement (USACE 2007), the U.S. Army Corps of Engineers (USACE) Manual (Environmental Laboratory 1987), and Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979). Therefore, the Service recommends the use of the Cook Inlet Classification (CIC) developed by Mike Gracz. The CIC is an HGM-based wetland ecosystem classification scheme analogous to Cowardin. The Service supports the use of CIC for wetland mapping in the Cook Inlet Basin over Cowardin because CIC is regionally specific and indicative of function (e.g., a spring fen always receives groundwater discharge; whether a palustrine emergent wetland does is unknown). CIC can be cross-walked with Cowardin if necessary. CIC methodologies and Mike Gracz' mapping protocols are described on www.cookinletwetlands.info.

In terms of compensatory mitigation related to a site that will be monitored over time using site-specific, precise functional attribution, the best functional assessment method available is the use of the HGM Regional Guidebooks. The citation for slope/flat wetlands is as follows:

- Hall, J.V., J. Powell, S. Carrick, T. Rockwell, G.G. Hollands, T. Walter and J. White. 2003. Wetland Functional Assessment Guidebook, Operational draft guidebook for assessing the functions of slope/flat wetland complexes in the Cook Inlet Basin Ecoregion, Alaska, using the HGM approach. State of Alaska, Department of Environmental Conservation, Juneau, Alaska.

Eagles and Raptor Nest Study (W-S3)

The Service's Migratory Bird branch is evaluating the potential for an eagle study that would compare productivity/behavior of golden eagles in disturbed areas (such as the Golden Valley Wind project, Usibelli Coal Mine, and the Susitna-Watana dam) versus undisturbed areas (Denali Park). We would like to explore the option of partnering with Watana projects to complete eagle nesting surveys. The Service could potentially provide experienced biologists to conduct the surveys. The benefits to this partnership include: 1) assistance to the project sponsors to conduct an eagle nesting survey; 2) provide cost savings to project sponsors by eliminating the need to hire a consultant to complete the survey; and 3) allow the Service to collect information valuable for our study. These surveys would not be considered compensatory mitigation, but would help meet eagle nest survey requirements. The Service generally recommends a pre-project survey with a follow-up survey just prior to construction.

Since 2009, compensatory mitigation is required for "take" or disturbance of active and inactive bald eagle nests. For golden eagles, there is a "no net loss" policy. Identifying ways to offset compensatory mitigation requirements early in the project development process can help the resource and the project sponsors. For example, a 2-year pre-construction eagle tracking study could help minimize required compensatory mitigation if the study demonstrated a "disturbance" rather than a "loss of territory."

Riparian (B-S2)

In addition to comments provided previously, we recommend riparian studies be integrated with other 2012 studies and with future project-related studies.

Beluga Prey Species Study (F-S6)

This study should identify components that specifically interface with the water resource and fish habitat studies. Anadromous prey species such as eulachon, Pacific and Arctic lamprey have been documented as present in the lower reach of the Susitna River and may be impacted by the proposed regulated flows. Relationships between natural flows and existing habitats should be developed to best predict changes during proposed regulated flows that may impact beluga whale prey species.

Instream Flow Planning Study (F-S5)

1) Selection of a model or series of models of 1D or 2D nature will drive the type of data needs for the field studies. This discussion and selection must be made prior to finalizing habitat studies.
2) The habitat suitability curve development is a useful product. Conduct the studies in such a manner as to ensure the development uses actual suitability data and is not dominated by best professional consensus.
3) Need a better understanding of how the instream flow study relates to the routing model or uses its own calibrated flow model. Concern is that the overall routing model may have significant variation in water level between cross-sections depending on their placement in relation to the habitat cross-sections. Location in pools or riffles and within these features or braided section will vary the water level of a certain flow and may not correctly interpret the water level of a habitat cross-section.
4) Anticipate that the habitat study will have its own cross-sections and flow analysis separate from the routing model. Realize that some selected locations may not be adequate once fieldwork is performed so flexibility is needed to select new spots as needed for 2013 and 2014.
5) Desire to have a large map with the routing and habitat cross-sections on it over recent aerial imagery.
6) In review of 1980s studies, were there any groundwater/surface water exchange studies?
7) Need to confirm whether the 1980s studies included mapping of groundwater upwelling areas along the river for gaining and losing reaches. We recommend at least a large-scale thermal temperature study along the river to note locations and relate it to the habitat study areas and cross-section surveys.

Reservoir and Flow Routing Model Transect Data Collection (WR-S1)

1) We recommend that the cross-section re-surveys in 2012 go beyond the forest limit but stay within the floodprone area, as there may be key floodplain elements not captured in the LIDAR data.
2) Need to evaluate appropriate model to consider ice effects as ice is a significant factor, not only for habitat but also for recreational use. We highly recommend utilizing one model that is fully dynamic and can deal with both floods and ice dynamics during winter low flows for routing. A model was recommended in the January work group discussion, created in Canada that may be appropriate. Model selection will drive data needs so this needs to be selected soon and with a full idea of the types of available models out there to select the best one.
3) Given the discussion of ice dynamics, cross-sections are likely needed in the lower reach to adequately assess ice dynamics as ice forms and slowly freezes upstream. We recommend that these cross-sections be identified and obtained in 2012 to maximize utilization of the model and potentially correlated to lower river habitat studies to reduce redundancy of effort.

4) Instream flow and habitat study cross-sections are assumed to be different than the routing cross-sections. We recommend creating a map for distribution that overlays the original routing and habitat cross-sections to begin to understand their spatial location and orientation and begin discussing 2012 study locations. Realize that some selected locations may not be adequate once fieldwork is performed so flexibility is needed to select new sampling locations as needed for 2013 and 2014.
5) Flows need to be measured to calibrate routing as much as possible. We recommend that water surface and flow be captured at key cross-sections while in the field to calibrate the routing model results and to verify Manning's n assumptions.

Determine Bedload and Suspended Sediment Load by Size Fraction at Tsusena Creek, Gold Creek, and Sunshine Gage Stations (G-S1)

1) For locations obtaining bedload data need to also do a bed pebble count to compare to transported load to calibrate for shear stress and other calculations.
2) Recommend that gravel bar sampling be part of the study to compare to transport load data obtained. This methodology must be well documented.
3) Evaluate the Chulitna and Talkeetna as well as other key tributary deltas for sediment distribution and load into the system.
4) Recommend attempting to get high flow values near bankfull stage at both Gold Creek and Watana sites to add to data.
5) Recommend sediment sampling at the Susitna-Watana dam site to demonstrate correlation to Gold Creek and/or model changes in sediment loading between the sites.
6) Evaluate 3-inch versus 6-inch bedload sampler use for 2012 field season to try to capture large fractions of bedload movement as able.

Geomorphic Assessment of Middle River Reach using Aerial Photography (G-S2)

1) Include a listing and evaluation of flood and ice conditions during and between aerial photography events, especially during breakup periods to help correlate differences to significant events in the watershed.
2) Does not address winter flows and habitat use under winter conditions; needs to come up with a plan to address this beginning winter 2012/13.
3) For geomorphic analysis and comparison to habitat studies, cross-section locations for substrate classification, large woody debris counts in floodprone width, and categorization of fluvial process (Montgomery and Buffington, Rosgen) should be determined and fieldwork performed. If location agrees with an old cross-section, it will help verify any changes over time and with flow to help determine stability and shear stress equations.

Geomorphic Assessment of Project Effects on Lower River Channel (G-S4)

1) There is a need to evaluate the hydrology and habitat use of the lower river to evaluate change over time from dam operations:
    a. Winter operations are a major concern given the need to evaluate daily flow fluctuations of 3,000-10,000 cfs in the winter. This effect must be modeled into

the lower reach to see if the magnitude of fluctuating flows in the winter extends further downstream than spring and summer flow periods. Additionally, ice and open water effects will be extended into the downstream area so modeling will need to address this by extending it downstream.

b. In the January work group meetings it was pointed out that ice is generated upstream and flows down the river to the lower reaches, beginning to form in the lower reach and slowly ice up the river upstream. This also needs modeling from a thermal standpoint, hence again, the need for cross-sections in the lower reaches.
c. Recommend that the gage at Su Station be turned on by the U.S. Geological Survey (USGS) and maintained by USGS to help calibrate lower reach modeling efforts over the next 5 years, especially for ice effects and dynamics modeling.
d. Cross-sections need to be made in the lower reach to add to an ice dynamics model as well as habitat studies – recommend selecting locations and getting these cross-sections in 2012 to facilitate modeling efforts.

2) Re-do all cross-sections at existing and past gage sites in the middle and lower reaches (including Su Station) to evaluate hydraulics, assess stability by comparing to old cross-section data and give an initial assessment of stability or changes in rating curve information. Also, it would be beneficial to do an initial evaluation of these gage sites at winter flows and with ice dynamics to begin to understand the impact winter flows will have. This will help with evaluating changes over the last 30 years in the lower reaches to determine whether additional work in 2013-2014 is needed.

Documentation of Sustina River Ice Breakup and Formation (G-S3)

1) Key elements to identify are: where ice generation occurs (production zones) and where ice lodges and begins the process of ice formation in the river.
2) Recommend that flights include an ice scientist, fishery biologist, riparian specialist and fluvial geomorphologist so that multiple observations can be made at the same time and can be stitched together to understand the processes taking place.
3) Recommend video be taken during all river flights for later reference.
4) Documentation of frazil ice generation is very important – current thought is that 80% is generated upstream of Devil's Canyon in the middle reach.
5) Daily flights might be needed during the height of breakup or freeze-up.
6) Is CRREL involved with the ice research?
7) Highly recommend utilizing our Canadian neighbors and their research and models for ice issues.

Review of Existing Water Temperature Data and Models (WQ-S1)

1) Identify appropriate temperature models to use based on new technology and understanding.
2) Evaluate MET station locations and strongly consider an additional station around the Deshka or Yentna which could help with ice studies.

3) Discuss MET station locations with NOAA Weather Forecast Center to access experts as well as potentially help with storing data.
4) Perform large-scale thermal study of the river for groundwater exchange areas over different flows.
5) At old, existing, and new gage sites, include continuous temperature monitoring; consider a water quality study at gage sites for 2012, 2013, and 2014 seasons with parameters agreed to by all parties and performed by USGS.
6) Evaluate past assumptions for temperature modeling (at least our understanding of it), i.e., summer analysis of surface water temperatures only, as this dominates habitat use, versus winter analysis of intergravel temperature only. Provide quantification of the hypothesis and assumptions made and determine if they are still relevant.
7) 2012 fieldwork in the work group meeting was discussed to primarily show how mainstem temperatures influence side channel habitat. This should be expanded to do a thermal analysis up and down the river (#4).
8) Discussed in the work group meetings that 2013-2014 work will deal with upwelling water temperatures. A thermal analysis in 2012 can help determine these sites.
9) Fieldwork needs to be performed that can help calibrate heat transfer coefficients and other assumptions in selected temperature models between mainstem and other waters.
10) Analysis of temperature effects on ice formation was not discussed and needs to be part of the scope in coordination with ice and habitat studies.
11) Ensure that solar radiation information will be collected at all MET sites as it is crucial to modeling efforts (ice, etc.) and evaluate other metrics that are needed for calibrating models.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Anchorage Fish and Wildlife Field Office
605 West 4th Avenue, Room G-61
Anchorage, Alaska 99501-2249

IN REPLY REFER TO:
AFWFO

February 21, 2012

Ms. Sara Fisher-Goad
Executive Director
Alaska Energy Authority
813 W Northern Lights Blvd
Anchorage, AK 99503

Re: Comments on an additional 2012 draft study plan for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241-0000

Dear Ms. Fisher-Goad:

The U.S. Fish and Wildlife Service (Service) is responding to the Alaska Energy Authority's (AEA) request for comments on 2012 pre-licensing draft study plans for the Susitna-Watana Hydroelectric Project. The Service provided initial comments on the draft study plans during the work group meetings January 24-26, 2012, and provided additional comments in our February 10, 2012, letter. The following comments and recommendations are based on our review of an additional draft study plan for the Susitna-Watana Hydroelectric Project provided in the Request for Proposals we received February 8, 2012. As in our February 10, 2012, letter, because of the short turnaround time requested for comments on the study plans and their ongoing evolution, our comments should be considered cursory.

Adult Salmon Distribution and Habitat Utilization (F-S3): The study objectives include characterizing the spawning habitat utilization of turbid mainstem and side channel habitats by adult anadromous species as well as the spawning habitat utilization in clear water side sloughs and upland sloughs. However, the methods only mention surveys in the Middle Reach (RM 98 to 150). We recommend that study methods be expanded to ensure characterization of spawning habitat utilization in the lower river reaches of the river as well to allow for a more comprehensive assessment of potential impacts of the project on salmon spawning habitats throughout the length of the Susitna River. In addition, we recommend that this study be fully integrated with instream flow and geomorphic studies to assess the effects of daily flow fluctuations, particularly in fall and winter.

Thank you for the opportunity to provide comments on the 2012 draft study plans for this proposed project. We look forward to continued coordination with AEA regarding resource appropriate studies. If you have any questions regarding these comments, please contact project biologist, Mike Buntjer at (907) 271-3053, or by email at michael_buntjer@fws.gov.

Sincerely,

Ann G. Rappoport
Field Supervisor

cc: S. Walker, NOAA, susan.walker@noaa.gov
E. Rothwell, NOAA, eric.rothwell@noaa.gov
T. Meyer, NOAA, tom.gcak.meyer@noaa.gov
E. Waters, BLM, ewaters@blm.gov
B. Maclean, BLM, bmaclean@blm.gov
C. Thomas, NPS, cassie_thomas@nps.gov
M. LaCroix, EPA, LaCroix.Matthew@epamail.epa.gov
J. Klein, ADF&G, joe.klein@alaska.gov
M. Daigneault, ADF&G, michael.daigneault@alaska.gov
G. Prokosch, ADNR, gary.prokosch@alaska.gov
D. Meyer, USGS, dfmeyer@usgs.gov
K. Lord, DOI, ken.lord@exchange.sol.doi.gov
B. McGregor, AEA, bmcgregor@aidea.org
W. Dyok, AEA, wdyok@aidea.org
B. Long, issues320@hotmail.com
C. Smith, TNC, corinne_smith@TNC.ORG
J. Konigsberg, HRC, jan@hydroreform.org
L. Yanes, ACE, louisa@akcenter.org
A. Moderow, ACA, andy@akvoice.org
P. Lavin, NWF, lavin@nwf.org
R. Wilson, Alaska Ratepayers, richwilsonak@gmail.com

Betsy McGregor

From: Bob_Henszey@fws.gov
Sent: Wednesday, March 07, 2012 9:33 AM
To: Klein, Joseph P (DFG)
Cc: Betsy McGregor; dreiser@r2usa.com; eric Rothwell; kfetherston@r2usa.com; mgagner@r2usa.com; Mike Buntjer; MaryLou Keefe; Steve Padula; susan walker
Subject: RE: Susitna-Watana - Instream Flow Study Request Discussion

Dudley,

I plan to attend. I have not had a chance to formalize my thoughts, but here's a few quick bullets to consider for riparian instream flow needs:

- Channel encroachment of riparian veg (appears to be recognized).
- Channel degradation lowering the adjacent water table, causing changes in adjacent veg (appears not to be recognized).
- Channel aggradation raising the adjacent water table, causing changes in the adjacent veg (not sure this will happen, but should be considered).
- Changes in the timing and duration of the hydroperiod (surface and shallow groundwater) on key riparian life stages (e.g., establishment, high flow and ice scour of seedlings, shifting high water levels to later in the season on mature veg)

These are all considerations that might affect migratory bird habitat in some of Alaska's most productive bird habitat (riparian).

Thanks,
Bob

Robert J. Henszey, Fish & Wildlife Biologist
Conservation Planning Assistance
US Fish & Wildlife Service
101 12th Avenue, Room 110
Fairbanks, AK 99701
Phone: 907-456-0323, Fax: 907-456-0208
Bob_Henszey@fws.gov

"Klein, Joseph P (DFG)" <joe.klein@alaska.gov>

03/07/2012 08:51 AM

To dreiser@r2usa.com, Mike Buntjer <michael_buntjer@fws.gov>, Bob_Henszey@fws.gov, eric.rothwell@noaa.gov, susan.walker@noaa.gov
cc "McGregor, Elizabeth A (AIDEA)" <bmcgregor@aidea.org>, Steve Padula <spadula@longviewassociates.com>, kfetherston@r2usa.com, MaryLou Keefe <mkeefe@r2usa.com>, mgagner@r2usa.com
Subject RE: Susitna-Watana - Instream Flow Study Request Discussion

Dudley, Thanks for your follow up – I am have some workload conflicts but believe I will still be able to call in this afternoon and will let you know if anything changes (albeit it may be posthumously if the fires jump the line). Following are some initial thoughts on major areas of concern to share with you and the group. I know more time will be needed to refine these topics and identify additional concerns and perhaps the discussion today and in future meetings will help to do this.

- Develop flow-habitat relationships with ability to assess observed "patchy" distribution of chum & sockeye spawning and juv rearing integrating fish behavioral based analyses (feeding niches, distance to cover & water edges, ground water influences, and/or water quality preferences, etc.)
- Development of site-specific HSC's for identified target species and life stages that is representative of habitat types, seasonal distribution, and inter-annual variability;
- Evaluation of winter habitat needs for identified target species and life stages; and
- Evaluation of surface – ground water fluxes in a representative sample of habitats used by fish and paired controlled sites. Parameters to investigate include source of origin, rates of exchange over time and space, relationship with mainstem flows, and water quality over time and space.

Joe Klein, P.E.
Supervisor Aquatic Resources Unit
Alaska Department of Fish and Game
333 Raspberry Rd
Anchorage, AK 99518
(907) 267-2148
joe.klein@alaska.gov

From: Dudley Reiser [mailto:dreiser@r2usa.com]
Sent: Wednesday, March 07, 2012 7:54 AM
To: Klein, Joseph P (DFG); 'Mike Buntjer'; Bob_Henszey@fws.gov; eric.rothwell@noaa.gov; susan.walker@noaa.gov
Cc: McGregor, Elizabeth A (AIDEA); Steve Padula; kfetherston@r2usa.com; 'MaryLou Keefe'; mgagner@r2usa.com
Subject: Susitna-Watana - Instream Flow Study Request Discussion

Hi Everyone – as I mentioned last week, I would like to have our first teleconference call today from 3:00 – 5:00 AST to solicit some focused discussion on technical issues and potential study elements that you would like considered as we progress in development of the 2013/2014 Study Plans. I think we touched on a number of those during the meeting but I feel like this would provide an opportunity for you bring up specific items/issues you believe warrant consideration. However, rather than get into too much detail, I would like the discussion to be more broadly based and to focus on major areas of interest or concern, e.g. Eric's discussion regarding load following and potential effects. Perhaps you might consider developing a list of resource issues and perhaps approaches for addressing those, that you think need to be carefully considered. The goal is to make sure we capture the major items in our initial Draft 2013/2014 Study Plan outlines.

Bob - Kevin Fetherston will be available on the call to discuss the riparian program during the later part of the call.

At this time, I am trying to see who is available and wants to participate in the call, and as well, asking for input regarding others you believe should also participate so I can include them on the invite. I will provide call-in instructions in a follow-up email.

That's it for now. Am looking forward to a good discussion.

Thanks

Dudley

Dudley W. Reiser, Ph.D.
R2 Resource Consultants, Inc.
425-556-1288 - office
Fax - 425-556-1290
425-681-6048 - cell

Email – SWIFS01

Betsy McGregor

From:	Susan Walker <susan.walker@noaa.gov>
Sent:	Wednesday, March 07, 2012 10:54 AM
To:	dreiser@r2usa.com
Cc:	Joe Klein - ADFG; Mike Buntjer; Bob_Henszey@fws.gov; eric Rothwell; Betsy McGregor; Steve Padula; kfetherston@r2usa.com; MaryLou Keefe; mgagner@r2usa.com
Subject:	Re: Susitna-Watana - Instream Flow Study Request Discussion
Attachments:	FERC Susitna Watana Hydro Proj P-14241 study 2012.pdf

Good morning Dudley,

Eric Rothwell has been trying to get an update on time and call-in numbers as he is travelling through remote locations today. He will try to call, but is unlikely be able to participate from the road. I, unfortunately, will not be available from 3 to 5 on this short notice either. Eric will email the group tomorrow about additional issues that he did not bring up at last weeks discussion.

I suggest starting with the comments and recommendations on instream-flow studies we provided to the AEA on our latest letter, which I have attached.

Given the planned load-following operations in winter and reduction of peak summer flows, it will be prudent to determine and document the constraints of instream flow studies to predict future, unknown changed habitat features and likely future flow-habitat relationships.
This is especially important in the middle river as the mainstem is expected to channelize over the long-term due to sediment source depletion and isolation of side and off-channel spawning and rearing habitat. It is also important in the lower river as reduced peak flows probably create conditions of channel aggradation - presenting similar limitations in the extension of instream flows and the need for integration of instream flow with geomorphology and other studies.

It is especially important to know:

how 2012 studies will factor into 2013-14 studies, and

what the linkages are between all of the related studies.

On Wed, Mar 7, 2012 at 7:53 AM, Dudley Reiser <dreiser@r2usa.com> wrote:
> Hi Everyone – as I mentioned last week, I would like to have our first
> teleconference call today from 3:00 – 5:00 AST to solicit some focused
> discussion on technical issues and potential study elements that you
> would like considered as we progress in development of the 2013/2014 Study Plans.
> I think we touched on a number of those during the meeting but I feel
> like this would provide an opportunity for you bring up specific
> items/issues you believe warrant consideration. However, rather than
> get into too much detail, I would like the discussion to be more
> broadly based and to focus on major areas of interest or concern, e.g.
> Eric's discussion regarding load following and potential effects.
> Perhaps you might consider developing a list of resource issues and
> perhaps approaches for addressing those, that you think need to be

> carefully considered. The goal is to make sure we capture the major items in our initial Draft 2013/2014 Study Plan outlines.
>
>
>
>
> Bob - Kevin Fetherston will be available on the call to discuss the
> riparian program during the later part of the call.
>
>
>
> At this time, I am trying to see who is available and wants to
> participate in the call, and as well, asking for input regarding others you believe
> should also participate so I can include them on the invite. I will
> provide call-in instructions in a follow-up email.
>
>
>
> That's it for now. Am looking forward to a good discussion.
>
>
>
> Thanks
>
>
>
> Dudley
>
>
>
>
>
> Dudley W. Reiser, Ph.D.
>
> R2 Resource Consultants, Inc.
>
> 425-556-1288 - office
>
> Fax - 425-556-1290
>
> 425-681-6048 - cell
>
>
>
> Email – SWIFS01
>
>
>
>
>
>

Sue Walker
NMFS Hydropower Coordinator
Alaska Region

P.O. Box 21668
709 W. 9th Street
Juneau, Alaska 99802-1668

907-586-7646
FAX: 907- 586=7358

SUSITNA-WATANA INSTREAM FLOW STUDY (SWIFS)
Teleconference Meeting Minutes
March 15, 2012

Project: Susitna-Watana Instream Flow Study
FERC No. 14241

Meeting Date: March 7, 2012 (3-5 PM AST)

Location: Via Teleconference

Participants: Joe Klein (ADFG), Mike Buntjer (USFWS), Betsy McCracken (USFWS), Susan Walker (NMFS), Bob Henszey (USFWS), Betsy McGregor (AEA), Craig Addley (Cardno-Entrix), Steve Padula (Longview), Dudley Reiser (R2), Paul DeVries (R2), Stuart Beck (R2), Kevin Fetherston (R2), Mike Gagner (R2), Michael Link (LGL)

Purpose: Continue discussions regarding instream flow related resource issues that need to be addressed as part of 2013-2014 studies.

Dudley Reiser stated that the main purpose was to allow resource agencies an opportunity to provide more details on resource issues warranting investigation as part of 2013-2014 studies. He reminded the group that there are opportunities for some field efforts this year.

Dudley noted the email comments provided by Joe Klein and requested that he expand on the issues he presented. Some of ADFG issues include:

- Model flow vs. habitat relationships in all reaches affected by the project
- Complete a comprehensive analysis of fish habitat issues including: distribution, use, timing, and evaluation of project impacts
- Ice and potential effects on formation, breakup, etc. related to project operations
- Winter habitat use of fish
- Groundwater influences on fish distribution and how project operations may affect groundwater flows
- Water temperature and how regimes would change with project operations
- Time series analysis of habitats

Dudley acknowledged the need to focus on both mainstem and side channel habitats and that previous studies focused on side channel and slough habitats. He noted that the flow routing transects could also be used for evaluating mainstem habitat effects and that the radiotelemetry (fisheries study) studies would be used to help define main channel use.

Joe Klein indicated he would like to see more emphasis on mainstem habitats than was done in the 1980s.

Mike Buntjer requested a map displaying location of flow routing transects. Betsy McGregor noted that the location of the old ADF&G transects in lower river would need to be digitized and displayed along with flow routing transects in the middle river. This type of info will be useful in identifying data gaps and possibly high priority sampling locations.

Joetta Zablotney is going to generate a GIS map using modern coordinates and aerial photos. This map will be distributed to the group as part of 2013/2014 study plan and will need to be completed by March 20th. Betsy noted that Shawn O'Quinn – (DNR GIS) will assist with this effort.

Craig Addley said that most of the 1980s transects have been digitized and could be displayed on new maps. The group would like to have the transect locations QA/QCed on the ground.

Betsy McCracken asked whether the historic transects were based on habitat or fish use? This will need to be determined based on information review. She also would like to see a study to define unique habitat types, especially those associated with groundwater upwelling.

Dudley stated that groundwater is specifically covered under water quality, but that groundwater influences relative to spawning and rearing habitats and the effects of project operations on these habitats will need to be evaluated. One way for identifying areas of groundwater inflow is via Forward Looking Infrared (FLIR). This has been proposed for use in a test area to see if sufficient difference in temperature can be detected. If works on test area, then it would be expanded to other areas. Some limited assessment of groundwater was done in the 1980s. Dudley noted that this relates to the idea of different levels of study intensities based on resource use/sensitivity. This will be considered in developing the 2013-2014 study plans.

Craig Addley noted that extensive habitat mapping was done during 1980s studies – the majority of side channel, mainstem, and off channel habitats (sloughs) were evaluated under flows ranging from ~800-2,400 cfs. Studies identified spawning locations, juvenile fish and overwintering use of each habitat type and many of these habitat types were subsampled.

The group indicated that load following and ramping rates are a major concern. Stuart Beck described a procedure for evaluating these types of potential impacts using a varial zone analysis that would include an evaluation of stranding and trapping potential, along with redd dewatering.

The agencies requested a list of contractors that identify who is responsible for what studies/issues. Dudley indicated he will work with AEA on getting a list generated. Not all contractors are under contract yet.

Question raised: How will we study or detect channel change with flow regulation changes; i.e., change in hydrology will result in channel changes. Answer – this will be done as part of a number of studies including geomorphology, riparian analysis, ice study, and the instream flow habitat analysis. Part of these studies will evaluate bed profile and substrate compositions.

Question raised: will the flow routing model be used for channel change – Stuart Beck indicated it would be. Stuart also noted that there are ways to predict how project operations will affect changes in morphology and that this will be linked with SWIFS and riparian studies.

Question raised: can the model also be used to evaluate tributary confluences and how they will be affected? S. Beck stated the project would result in sediment supply interruptions – immediately below the dam the sediment supply will change with scour or incision, but some of this impact will be reduced by reductions in high flow events. The USGS is evaluating sediment changes.

Dudley noted that the overall goal is to try and link all of the channel and biological processes that may be affected by the project operations so that time series evaluations can be completed for each process (to the extent possible).

Question raised: will invertebrates be considered in the assessment of project effects? D. Reiser responded that changes in sediment and flow can affect invertebrates and they will be considered. May utilize varial zone analysis described by S. Beck to assess some of these impacts including area, timing, and duration of projected flow changes.

Question raised: will HSC curves be developed for invertebrates? D. Reiser noted that this has been done on other projects and will be considered as part of the SWIFS. However, it also possible that the issue of invertebrate habitats will be covered by fish habitat analysis, that may include use of guilds. Betsy McCracken is interested in potential changes that may result to invertebrate species richness and diversity.

The group noted that Project operations will alter the thermal regime related to flow releases, ADF&G would like to see HSC curves developed for multiple areas and over different time periods/flow levels. D. Reiser responded that we will conduct site-specific data collection but may need to use literature, professional opinion, enveloping and guiding to develop curve sets for some species.

Question raised: how many observations are necessary to build curves? D. Reiser noted this varies; some instances as few as 25-30 observations have been used, in others 75-100 or more have been used. Joe Klein stressed that he just wants to make sure that a good effort was going to be placed on collecting site-specific data.

Concerning the review of literature review and gap analysis/synthesis that will be undertaken this year, the agencies would like to be directed to pieces of information we identify that are especially useful to help them gain a good understanding the resources of the project area.

The group then shifted to a discussion of Riparian habitat. Bob Henszey asked about the types of studies that would be done to assess channel encroachment and the effects of project operations on cottonwood regeneration. He is concerned about potential effects of shallow groundwater table fluctuations and how that would influence cottonwood recruitment.

K. Fetherston indicated that models will be used to predict project operational effects on cottonwood/riparian veg. Joe Klein asked whether there is a published table that shows how seral stages and spp composition change over time. K. Fetherston noted that HEC-RAS and HEC-GeoRAS can be used to determine flow vs. riparian habitat relationships. This work will be coordinated with the ice assessment group and how conditions/ice sheer zones will affect cottonwood galleries. It will also be important to link riparian studies with groundwater, and fisheries at certain locations. Kevin noted that large fluctuations in flow can also increase bank erosion affecting riparian vegetation. The approach will be to intensively study small areas with the goal of being able to extrapolate results out to unsampled areas.

The teleconference adjourned at 5:00 ADT.

SUSITNA-WATANA
HYDROELECTRIC PROJECT

RECORD OF TELEPHONE CONVERSATION

AEA Team Member		Other Party	
Name:	*Kevin Fetherston*	**Name:**	*Bob Henszey*
Organization:	*R2 Resource Consultants*	**Organization:**	*USFWS*
Study Area:	*Riparian Instream Flow*	**Phone Number:**	
Date:	*5/18/12*	**Time:**	
Call Placed by: ☐ AEA Team ☐ Other Party			

Others on Call:

Subject: Riparian Instream Flow Study Design

Discussion:

The salient issues discussed include:

1. Bob is concerned that we have intensive study reaches located below the Dam site to assess channel issues relative to channel degradation due to lack of sediment transport. I assured him we plan on having a number of sites between the dam site and three rivers.

2. Bob is concerned that we have enough well transects at our intensive study reaches to capture all the riparian plant community types found in the Susitna River floodplain. This is dependent upon the extent of the dam hydrological influence and the number of plant community types we identify within these reaches.

3. Bob is interested in the study characterizing groundwater root zone interactions. This is included in our groundwater/surface water study design.

SUSITNA-WATANA HYDROELECTRIC PROJECT

RECORD OF TELEPHONE CONVERSATION

AEA Team Member		Other Party	
Name:	*Kevin Fetherston*	**Name:**	*Jason Mouw*
Organization:	*R2 Resource Consultants*	**Organization:**	*ADF&G*
Study Area:	*Riparian Instream Flow*	**Phone Number:**	
Date:	*5/22/12*	**Time:**	

Call Placed by: [X] AEA Team [ ] Other Party

Others on Call:

Subject: **Riparian Instream Flow Study Design**

Discussion:

I contacted Jason Mouw, AK Fish & Game riparian ecologist, regarding his ten years of experience studying riparian floodplain forests on the Talkeetna and Susitna rivers and his general knowledge regarding floodplain plant community research in the region.

Primary issues we discussed include:

1. Balsam poplar phenology, seed release period he has observed on the Susitna River (seed release generally in the window of June 20-July 4th),
2. Dendrochronological studies he is conducting on the Talkeetna River floodplain,
3. Types of historic river gauge data, and
4. General ecology of riparian forest succession he has observed.

SUSITNA-WATANA
HYDROELECTRIC PROJECT

RECORD OF TELEPHONE CONVERSATION

AEA Team Member		Other Party	
Name:	*Kevin Fetherston*	**Name:**	*Bob Henszey*
Organization:	*R2 Resource Consultants*	**Organization:**	*USFWS*
Study Area:	*Riparian Instream Flow*	**Phone Number:**	
Date:	*5/25/12*	**Time:**	

Call Placed by: [X] AEA Team [ ] Other Party

Others on Call:

Subject: Riparian Instream Flow Study Design

Discussion:

I spoke with Bob Henszey, USFWS, today concerning the riparian floodplain sampling design. He was interested in understanding more of the specific elements of our proposed riparian vegetation sampling design approach. Specifics included:

1. Riparian vegetation seedling survey approach (where, spatially riparian plants colonize the floodplain),
2. Characterization of seedling colonization site environmental parameters (floodplain substrate texture and depth),
3. Measurement approach to ice processes floodplain vegetation interactions,
4. Groundwater / surface water interaction and floodplain vegetation modeling approach.

SUSITNA-WATANA HYDROELECTRIC PROJECT

MEETING RECORD

AEA Team Member		Other Party	
Name:	*Dudley Reiser*	**Name:**	*Agency representatives*
Organization:	*R2 Resource Consultants*	**Organization:**	*ADFG, USFWS, NMFS, EPA*
Study Area:	*Instream Flow Program*	**Phone Number:**	
Date:	*June 13, 2012*	**Time:**	*1:00*
Meeting held by: [x] AEA Team [ ] Other Party			

Others at meeting: Ron Benkert, Joe Klein - ADF&G, Matt LaCroix - EPA, Mike Buntjer, Betsy McCracken, Bob Henszey-USFWS, Sue Walker (via telephone) – NMFS, Michael Lilly-GW Scientific, Kevin Fetherston, Phil Hilgert – R2, Bill Fullerton, Mike Harvey, Bob Mussetter – Tetra Tech

Subject:
Identify level of interest and potential timing of a Susitna River site visit to review potential study sites and discuss instream flow/riparian/geomorphology modeling methods.

Discussion:
An agency site visit is scheduled during late July; but meeting participants expressed an interest in reviewing potential instream flow/riparian/geomorphology study sites after the contractors have made a preliminary selection. The general consensus was that a 1-day meeting in Anchorage could be used to review potential model applications, followed by a 1-2 day site visit. Low flow is end of September which provides good site viewing conditions; however, icing can start in early October. A field trip in mid-to-late September should provide sufficient opportunity for contractors to identify potential sites yet minimize the risk of early winter weather cancelling the trip.

Transportation by jet boat is preferred to helicopter; helicopters are frequently unable to fly due to fog and poor flying conditions in the fall. The reach from the 3 Rivers confluence up to Camp Curry exposes people to the major habitat types; perhaps 4 stops could be made in a long day. Mahays River Service is set up for river tours (http://www.mahaysriverboat.com/); discussion focused on a party of about 15 people: 2 ADFG, 2 AEA, (Eric or Sue) NMFS, 2 TT, 2 R2, 1 HDR, Mike Lilly, 4 open spots?

Agency staff will have to pay travel costs so they may have a budget issue in trying to participate. Costs should be identified as soon as practical. Accommodations at the Talkeetna Lodge may be an option after Labor Day.

Action Item:
Schedule trip for mid –to-late-September
Jet boat instead of helicopter
Pre-trip meeting, 2 field days, ½ day follow-up meeting

Prior to field trip R2 to distribute agenda and meeting packet (maps, draft site selection, etc.)

Winter Sampling
Following discussion of the site visit, the general discussion turned to winter sampling. How do fish behave during the winter? Are they torpid and seek out low velocity refuge areas? Could fish use lower Devils Canyon during winter base flow conditions? Data will be needed to evaluate Project effects.

Whiskers Slough is a productive area that is accessible by 4-wheel drive or snow machine during winter. Winter conditions could possibly be conducted at that site. Winter sampling will be difficult and potentially hazardous and the site should be very accessible to try out alternate sampling methods while maintaining safe working conditions. Up to the Indian River area, locals use snowmobiles for transportation – helicopters are used above Indian River. High water velocities immediately below Devils Canyon create unsafe ice for over ice travel. If fish studies are contemplated during the winter, they should coordinate with ice measurement crews to allow back-up (safety margins).

SUSITNA-WATANA
HYDROELECTRIC PROJECT

MEETING RECORD

AEA Team Member		Other Party	
Name:	*Kevin Fetherston*	**Name:**	*Agency representatives*
Organization:	*R2 Resource Consultants*	**Organization:**	*ADFG, USFWS, EPA*
Study Area:	*Riparian Instream Flow Program*	**Phone Number:**	
Date:	*June 14, 2012*	**Time:**	*2:00*
Meeting held by: [x] AEA Team [ ] Other Party			

Others at meeting: Joe Klein - ADF&G, Matt LaCroix - EPA, Mike Buntjer, Betsy McCracken, Bob Henszey-USFWS, Michael Lilly-GW Scientific, Dudley Reiser, Phil Hilgert – R2

Subject:
Riparian Instream Flow 2013-2014 Study Plan Approach and Design.

Discussion:

The riparian instream flow meeting was put together by Bob Henszey and Kevin Fetherston to explore and discuss in depth the 2013-2014 Riparian Instream Flow Study Plan approach and design. The following topics were discussed:

1. General overview of Riparian Instream Flow Study Plan.
2. Details of study approach, sampling designs, and modeling.
3. Operational flow effects on floodplain processes and vegetation and how to approach modeling these potential effects.
4. Floodplain soils characterization methods.
5. Groundwater well types and installation methods.
6. Plant community study design.
7. Riparian vegetation flow-response guilds and statistical modeling methods.
8. Role of beaver in generating floodplain plant communities: beaver dams, pools and wetland complexes.
9. Role of various floodplain vegetation disturbance types: flooding, channel migration, ice scour, herbivory, wind, and fire.
10. Potential for operational flows to alter floodplain conditions favoring exotic plant species invasions.

Action Item:

None

7. FISH AND AQUATIC RESOURCES

7.1. Introduction

Project construction and operation will affect flow, water depth, surface water elevation, and sediment regimes in the mainstem channel as well as at tributary confluences, side channels, and sloughs, both in the area of the inundation upstream from the proposed dam site and downstream in the potential zone of project hydrologic influence. Such modifications may have an adverse effect upon the aquatic communities and fish populations residing in the river, the degree of which will ultimately depend on final Project design and operating characteristics.

The potential effects of the Project on fish and aquatic resources will need to be carefully evaluated as part of the licensing process. This study plan describes the Susitna-Watana Fish and Aquatic Resources Study that will be conducted to characterize and evaluate these effects. The overall objectives of this study are to provide a baseline characterization of existing resources, to collect information that will support the evaluation of potential resource impacts of the proposed Project that were identified during development of the PAD, public comment, and FERC scoping for the License Application. This study will be subject to revision and refinements in consultation with licensing participants as part of the continuing study planning process identified in the ILP. The impact assessments will inform development of any necessary protection, mitigation, and enhancement measures to be presented in the draft and final License Applications.

AEA is committed to conducting a thorough evaluation of the aquatic resources that could potentially be affected by the Susitna-Watana Hydroelectric Project. AEA recognizes that the Susitna River supports a diverse assemblage of fish and aquatic biota and provided a detailed description of these resources in the PAD; however, AEA acknowledges that more information is needed to provide a better understanding of the species interaction with and dependencies on the river. To this end, AEA has initiated baseline studies on hydrology and fish resources in the lower, middle and upper Susitna River in 2012. These 2012 studies will be carried forward in the formal FERC ILP study program in 2013 and 2014. In addition, AEA is proposing to implement 15 additional fish and aquatic studies in 2013 and 2014 that will further document current conditions and provide information that will support the assessment of potential Project impacts.

The actual assessment of potential impacts will rely on information provided by the fish resources studies (See sections 7.5 through 7.16), the instream flow study (surface water flow routing during ice-free conditions; see Section 6.5), the geomorphology study (sediment supply/transport regime and channel morphology; see sections 5.8 and 5.9), ice processes study (surface water flow routing during the winter, ice growth and break up; see Section 5.10), groundwater study (surface water/groundwater interactions; see Section 5.7), and riparian instream flow botanical surveys (See Section 6.6). These studies will result in development of a series of flow sensitive models (e.g., models of selected anadromous and resident fish habitats by species and life stage, models to assess connectivity and passage conditions provided into side channel and slough habitats, models to describe invertebrate habitats, temperature model, ice model, sediment transport model, turbidity model, large woody debris (LWD) recruitment model) that will be able to translate effects of alternative Project operations on the respective processes and biological resources. Because alternate Project operational scenarios will likely affect different habitats and processes differently, both spatially and temporally, the habitat and process models will be spatially discrete (e.g., by site, segment, and reach) and yet able to be integrated to allow for a holistic evaluation of each alternative operational scenario. This will allow for an Integrated Resource Analysis of separate operational scenarios that includes each resource element, the results of which can serve in a feedback capacity leading to new or modifications of existing operations scenarios.

One of the key benefits to this approach is that AEA will be able to evaluate the potential effects of Project operations under different hydrologic conditions (e.g. wet, normal and dry year) and for varying time steps (e.g. hourly, daily, monthly etc.). This will allow for assessments of a wide range of operational characteristics including load following, base load operations, and others. These types of analysis can be extended over variable time intervals that can be used to assess Project effects over a life cycle of a given species. For example, Project operational effects could be evaluated over five year (or other specified interval) increments of time as a means to estimate how Chinook salmon (or other species) habitats might vary over that period (taking into consideration all of the flow-sensitive parameters noted above). These types of analyses could be done both retrospectively as a means to consider influences of existing and historic flow conditions, as well as prospectively as a means to evaluate effects of future project operations.

The information that will be collected and the models developed will be crucial to FERC for completing a thorough environmental impact assessment and for establishing appropriate protection, mitigation, and enhancement measures for inclusion in the Project license necessary for avoiding, reducing, or mitigating for Project effects.

AEA has carefully considered the importance of the Susitna River and its resources and while working diligently with licensing participants and technical consultants has identified and designed the studies presented herein in the PSP. All of the studies are planned to be completed in a timely fashion to support the license application and AEA is confident the information generated will provide FERC with sufficient information to complete its analysis. AEA's confidence in this matter is strengthened substantially owing to the extensive amounts of data and information that were collected on the Susitna River during the 1980s that formed much of the basis for the PAD. AEA has acquired the majority of the data and information collected during those studies and in 2012 has sanctioned the technical review and compilation of the information so it will be available for use during the 2013-2014 studies and for impact analysis. The results of the two years of intensive study as described in this PSP, coupled with the extensive amount of pre-existing, relevant information collected during the 1980s and ongoing efforts in 2012 will provide FERC the information and analysis needed to complete a sound, scientific assessment of the baseline conditions and potential Project.

7.2. Nexus Between Project Construction / Existence / Operations and Effects on Resources to be Studied

As described above, the construction and operational strategy of the Project will create a reservoir, modify the flow, thermal, gravel recruitment and sediment regimes, and may alter connectivity of aquatic habitats in the Susitna River basin. These potential ecosystem changes will alter the composition and distribution of fish habitat and may have effects on fish and aquatic productivity. The proposed hydropower operations for the Project may influence the abundance and distribution of one or more of the resident and anadromous fish populations. The degree of impact will necessarily vary depending on the magnitude, frequency, duration, and timing of flows as well as potential Project-related changes in temperature and turbidity. Baseline information on existing conditions will be needed, to predict the likely extent and nature of potential changes that will occur due to Project construction and operations.

7.3. Agency and Alaska Native Entities Resource Management Goals and Objectives

Aquatic resources including fish and their habitats are generally protected by a variety of state and federal mandates. In addition, various land management agencies, local jurisdictions, and non-governmental interest groups have specific goals related to their land management responsibilities or special interests. These goals are expressed in various statutes, plans, and directives:

Alaska Statute 41.14.170 provides the authority for state regulations to protect the spawning, rearing, or migration of anadromous fish. Alaska Statute 41.14.840 regulates the construction of fishways and dams. State regulations relating to fish resources are generally administered by ADF&G. ADF&G is responsible for the management, protection, maintenance, and improvement of Alaska's fish and game resources in the interest of the economy and general well-being of the state (AS 16.05.020). ADF&G monitors fish populations and manages subsistence, sport and commercial uses of fish through regulations set by the Board of Fisheries (AS 16.05.221). The *Policy for Management of Sustainable Salmon Fisheries* (SSFP; 5 AAC 39.222) sets guidelines for ADF&G's management of State salmon resources. The statewide *Policy for the Management of Sustainable Wild Trout Fisheries* (PMSWTF; 5 AAC 75.222) currently guides wild rainbow trout regulatory changes. Cook Inlet Rainbow Trout/Steelhead Management Policy (CIRTMP; ADF&G 1987) provides further guidelines specific to rainbow trout in the Northern Cook Inlet Management Area (NCIMA). ADF&G's authority for protection of fish resources and habitat if further established through the Anadromous Fish Act (AS 16.05.871 – 901) and the Fishway Act (AS 16.05.841).

In addition to the state statutes, the following resource management plans and directives provide guidance and direction for protection of fish resources and aquatic habitats on lands within or adjacent to the Project area:

- Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA) passed in 1980 set forth a subsistence use priority for the taking of fish and wildlife on public lands.
- The Federal Subsistence Board, which comprises representatives of the U.S. Fish and Wildlife Service, National Park Service, Bureau of Land Management, Bureau of Indian Affairs, and U.S. Forest Service, oversees the Federal Subsistence Management Program (57 FR 22940; 36 CFR Parts 242.1–28; 50 CFR Parts 100.1–28), with responsibility for managing subsistence resources on Federal public lands for rural residents.
- Magnuson-Stevens Fishery Conservation and Management Act (PL 104-267) provides federal protection for Essential Fish Habitat (EFH) defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." NOAA's

National Marine Fishery Service (NOAA Fisheries) is responsible for designating EFH. In the case of anadromous fish streams (principally salmon), NOAA Fisheries has designated the AWC prepared by ADF&G (Johnson and Klein 2009) as the definition of EFH within freshwater habitats.

- Aquatic Resources Implementation Plan for Alaska's Comprehensive Wildlife Conservation Strategy, September 2006. Prepared by ADF&G, Division of Sport Fish.
- Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources. Prepared by ADF&G, Juneau, Alaska. xviii+824 pp.

Management and land use plans relevant to Fish and Aquatic Resources Study components include the following:

- The role of state land use plans, generally administered by Alaska Department of Natural Resources (DNR), was established by state statute (AS 38.04.005). The Susitna-Matanuska Area Plan (SMAP) and The Southeast Susitna Area Plan (SSAP) direct how the DNR will manage general state uplands and shorelands within the planning boundaries.
- The Susitna Basin Recreation Rivers Management Plan describes how the Department of Natural Resources (DNR) will manage state land and water along six rivers including: the Little Susitna River, Deshka River, Talkeetna River, Lake Creek, Talachulitna River, and Alexander Creek. The plan determines how these six rivers will be managed over the long term including providing management intent for each river segment, new regulations for recreation and commercial use, and guidelines for leases and permits on state land.
- The Susitna Flats Game Refuge Management Plan provides ADF&G guidance to manage the refuge to protect fish and wildlife populations, including salmon spawning and rearing habitats.
- Chickaloon Native Village is an Ahtna Athabascan Indian Tribe and is a federally recognized Alaska Native tribe. The Chickaloon Village Traditional Council strives to increase traditional Ahtna Dene' practices for the betterment of all residents in the area. The Tribe envisions a future with functioning ecosystems, flourishing fish and wildlife populations and a healthy, prosperous community.

7.4. Summary of Consultation with Agencies, Alaska Native Entities and Other Licensing Participants

Input regarding the issues to be addressed in the Fish and Aquatic Resources Study has been provided by licensing participants during workgroup meetings commencing in late 2011. During 2012, workgroup meetings were held in January, February, April and June during which resource issues were identified and discussed and objectives were defined. Various agencies (USFWS, NMFS, ADF&G, etc.) provided written comments specific to this study which have been considered and will be addressed as part of this plan. A summary of consultations relevant to fish and aquatics resources is provided in Table 7.4-1.

Table 7.4-1. Summary of consultation on Fish and Aquatic Resources study plans.

Comment Format	Date	Stakeholder	Affiliation	Subject
Letter	12/30/2011	A.G. Rappoport	USFWS	Critically review 1980s data for applicability to current Project. Quantify fish distributions and collect longitudinal thermal imaging data.
Letter	01/12/2012	P. Bergmann	USDOI	Fully characterize fish habitat use, HSC, species and assemblages throughout all three reaches of the Susitna River and tributaries, address climate change in studies, invasive species, effects of flow changes on fish passage through Devils Canyon. (Filed with FERC.)
Technical Workgroup Meeting Notes	01/25/2012	Various	AEA, USFWS, NMFS, BLM, NPS, ADF&G, ADNR, FERC, The Nature Conservancy, Natural Heritage Institute, Alaska Conservation Alliance, Knik Tribe, Knikatnu Inc, Nuvista Light & Power, and other interested parties	Meeting to discuss Project and 2012 Fisheries Study Plans. See Attachment 1-1.
Letter	02/10/2012	A.G. Rappoport	USFWS	Use minimum 5-year temporal scale, include winter evaluations beginning in 2012, conduct thermal imaging, use 2-D models, use site-specific data instead of professional judgment for HSC,
Letter	02/21/2012	A.G. Rappoport	USFWS	Requested that Adult Salmon Distribution and Habitat Utilization Study be integrated with instream flow and expand spawning habitat study to lower river.
Letter	02/29/2012	J.W. Balsiger	NMFS	Requested information on how interrelated studies will be integrated, requested climate change be incorporated into many, if not all studies. (Filed with FERC.)
Technical Workgroup Meeting Notes	03/01/2012	Various	AEA, USFWS, NMFS, BLM, NPS, ADF&G, ADNR, FERC, Natural Heritage Institute, Hydropower Reform Coalition, Susitna River Advisory Committee,	Meeting to discuss Project and 2012 Fisheries Study Plans and table of proposed 2013-2014 studies, potential methods and objectives. See Attachment 1-1.

Comment Format	Date	Stakeholder	Affiliation	Subject
			Alaska Ratepayers, and other interested parties	
Meeting Notes	03/02/2012	J. Erickson	ADF&G	Discussion of conceptual study designs for salmon escapement studies in the Susitna River.
Meeting Notes (Prepared by D. Reiser)	03/07/2012	S. Walker, M. Buntjer, B. McCracken, B. Henszey, J. Klein	NMFS, USFWS, ADF&G	Written summary of teleconference meeting held on 03/07/2012 to discuss 2012 and 2013/2014 studies. Topics included: model flow vs. habitat relationships in all reaches affected by the Project; complete analysis of fish habitat issues, ice and potential effects of Project on formation, breakup, etc., fish use of winter habitat; groundwater and water temperature and potential Project influences; time series analysis of habitats; and evaluation of riparian communities under alternate Project operations.
E-mail	03/28/2012	J. Erickson, R. Yanusz, M. Willette, L. Fair	ADF&G	Email request for comments on the draft 2012 study plan, which is the basis for the 2013-14 Salmon Escapement Study Plan
Phone Call	03/30/2012	J. Erickson	ADF&G	Follow up to review comments on the 2012 escapement/habitat utilization study plan; the 2013-14 study plan derived directly from the 2012 study plan.
Technical Workgroup Meeting Notes	04/05/2012	Various	AEA, ADNR, ADF&G, BLM-Glennallen, FERC, NMFS, USFWS,USGS, Mike Wood, Natural Heritage Institute, The Nature Conservancy, and other interested parties	Meeting to discuss 2012 study plans and 2013-2014 Study Requests prepared by AEA team. See Attachment 1-1.
E-mail	04/17/2012	J. Klein	ADF&G	Comments on April 2-6 Technical Workgroup Meetings.
E-mail	04/23/2012	M. Bunjer	USFWS	See written comments on study requests:
Teleconference	04/26/2012	S. Walker, E. Rothwell, M. Buntjer, B. McCracken, J. Erickson, J. Klein, M. Sondergaard, M. Cutlip	NMFS, USFWS, ADF&G, BLM, FERC	Open discussion of objectives and approaches to consider in 2013-14 study plans.
Meeting Notes	04/26/2012	B. Templin, C. Habicht, A. Barclay (ADF&G); AEA	ADF&G Gene Lab	Discussion of genetic sampling needs in the Susitna Watershed, which samples to collect in 2013-14, and

Comment Format	Date	Stakeholder	Affiliation	Subject
		contractors (LGL, R2, and HDR)		potential uses to project impact assessment, fishery management, and stock assessment (including estimating abundance of Chinook salmon).
E-mail	05/01/2012	M. Buntjer	USFWS	Mike delivered several historic documents (1950s – 1960s) that were in house at USFWS to the Fisheries Consulting Team .
E-mail	05/04/2012	M. Buntjer	USFWS	Delivery of draft river productivity study request to USFWS for preview.
Phone call	05/14/2012	M. Buntjer	USFWS	Mike called and we discussed various aspects of several fish studies including winter fish sampling, early life history, and river productivity. With respect to winter sampling we discussed pros and cons of potential methods and our experience on other systems. We discussed the need for the early life history to address the Project nexus. Mike also suggested that the USFWS would like us to add particulate organic matter (POM) to the data collection effort under the river productivity study.
Meeting Notes	05/17/12	J. Buckwalter	ADF&G	Upper River fisheries studies – tributaries to sample for Chinook salmon, field sampling logistics, Odyssey Fisheries Database System
Teleconference	05/18/2012	M. Buntjer, B. McCracken, S. Walker, R. Benkert	USFWS, NMFS, ADF&G	Open discussion of winter sampling methods to consider.
Study Requests, Letters	05/30/2012 - 05/31/2012	Various	Multiple Stakeholders	Stakeholders' comments on PAD, SD1 and study requests. (Filed with FERC.)
E-mails (several)	06/07/2012	J. Klein, M. Buntjer, B. Henszey, S. Walker	NMFS, USFWS, ADF&G	Reponses to request for follow-up post-stakeholder meeting to be held in the afternoon of 06/13/2012.
Technical Workgroup Meeting Notes	06/12/2012	Various (see meeting record)	Multiple Stakeholders	Meeting to discuss Stakeholder Study Requests.
Teleconference	06/20/2012	M. Buntjer, B. McCracken, S. Walker, R. Benkert, j. Erickson	USFWS, NMFS, ADF&G	Follow up from the TWG meeting on 12 June 2012. Discussion of sampling design for macroinvertebrates including sampling in channel margins and wood as a substrate. Clarification of semantic issues regarding escapement versus counts and all species versus all species captured.

Comment Format	Date	Stakeholder	Affiliation	Subject
Meeting Notes	06/21/2012	J. Erickson	ADF&G	ADF&G provided the text of the request for the fish genetics study, which the fish genetics study plan is largely built on.
Meeting Notes	06/26/2012	M. Miguera, B. Mahoney, K. Savage, J. Klein, M. Burch, B. Small	NMFS, ADF&G	Meeting to discuss FERC process, 2012 Cook Inlet Beluga Whale (CIBW) Study, 2013-2014 CIBW Study and fish prey studies on eulochon, Chinook, chum, sockeye and coho salmon.
E-mail	06/28/2012	J. Erickson	ADF&G	LGL and ADF&G discuss genetics and escapement study plans, estimating Chinook salmon abundance using genetic-based methods, and relative effectiveness of different methodologies to estimate salmon abundance in the lower, middle, and upper Susitna.
Phone Call	07/10/2012	S. Ivey	ADF&G	Coordination between HDR and ADF&G for Chinook salmon aerial spawning surveys in Indian River.
E-mail	07/10/2012	J. Erickson	ADF&G	Coordination with ADF&G for Chinook salmon aerial spawning surveys in Indian River.
E-mails	05/14/2012, 05/21/2012, 07/12/2012, 07/13/2012	B. Piorkowski, C. Habicht, J. Berger, S. Ivey, M. Bethe, A. Barclay, M. Daigneault, L. Boyle	ADF&G	Various dialogues between HDR and ADF&G regarding Fish Research Permit SF2012-151 for the Upper River Fisheries Distribution and Abundance Study stipulations, amendments and compliance.

7.5. Study of Fish Distribution and Abundance in the Upper Susitna River

7.5.1. General Description of the Proposed Study

This study is focused on fish species that use the Susitna River upstream of Devils Canyon. Fishery resources in the upper sections of the Susitna River basin consist of a variety of salmonid and non-salmonid resident fish (Table 7.5-1). With one known exception (i.e., Chinook salmon), existing information indicates that anadromous fish are restricted to the mainstem Susitna River and tributaries downstream of Devils Canyon near RM 150 due to their apparent inability to pass several steep rapids. In addition to the resident salmonid and non-salmonid fishes present in this part of the river, this study will also investigate the distribution and abundance of any anadromous fish that have passed upstream of Devils Canyon. Chinook salmon are known to pass Devils Canyon at relatively low numbers (maximum peak count of 46 adult Chinook salmon during 1984; Thompson et al. 1986).

The physical habitat modeling efforts proposed in Section 6.5 of this PSP require information on the distribution and periodicity of different life stages for the fish species of interest. Not all life stages of the target fish species may be present throughout the Upper Susitna River, and seasonal differences may occur in their use of some habitats. For example, some fish that use tributary streams during the open-water period may overwinter in mainstem habitats.

This study is designed to provide baseline biological information regarding periodicity and habitat suitability for the Instream Flow Modeling Study (see Section 6.5). Results of this study will include key life history information about fish species in the Upper Susitna River based on two sampling approaches. The first sampling approach will involve active and passive capture methods to identify the seasonal timing, distribution, and abundance of fish at a variety of locations and habitat types upstream of Devils Canyon. The second sampling approach will be the use of biotelemetry to monitor the movements and habitat utilization of radio-tagged fish.

7.5.1.1. Study Goals and Objectives

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

1. Describe the seasonal distribution, relative abundance (as determined by CPUE, fish density, and counts), and fish-habitat associations of resident fishes, juvenile anadromous salmonids, and the freshwater life stages of non-salmon anadromous species;
2. Determine whether Dolly Varden and humpback whitefish residing in the upper river exhibit anadromous or resident life histories;
3. Collect tissue samples to support the *Genetic Baseline Study for Selected Fish Species* (Section 7.14);
4. Determine baseline metal concentrations in fish tissues for resident fish species in the mainstem Susitna River (see *Mercury Assessment and Potential for Bioaccumulation Study*, Section 5.12);

5. Use biotelemetry (PIT and radio tags) to describe seasonal movements of selected fish species (including rainbow trout, Dolly Varden, whitefish, northern pike, burbot, and Pacific lamprey if present) with emphasis on identifying spawning and overwintering habitats within the hydrologic zone of influence upstream of the project;
6. Document the timing of downstream movement and catch for fish species via outmigrant traps; and
7. Document the presence/absence of northern pike in all samples.

7.5.2. Existing Information and Need for Additional Information

Information regarding resident species, non-salmon anadromous species, and the freshwater rearing lifestages of anadromous salmon was collected during studies in connection with APA's proposed Susitna Hydroelectric Project in the 1980s. Existing information includes the spatial and temporal distribution of fish species and their relative abundance. The Pre-Application Document (PAD) (AEA 2011a) and Aquatic Resources Data Gap Analysis (ARDGA; AEA 2011b) summarized this existing information and also identified data gaps for resident and rearing anadromous fish.

A total of nine anadromous and resident fish species have been documented inhabiting the Susitna River drainage upstream of Devils Canyon (Table 7.5-1). Chinook salmon use of the Upper Susitna River was first documented during the 1980s studies; this is the only anadromous fish documented to pass the rapids at Devils Canyon. Resident species that have been identified in all three reaches of the Susitna River include Arctic grayling, Dolly Varden, humpback whitefish, round whitefish, burbot, longnose sucker, and sculpin. To varying degrees, the relative abundance and distribution of these species were determined during the early 1980s studies. For most species, the dominant age classes and sex ratios were also determined, and movements, spawning habitats, and overwintering habitats were identified for certain species.

One species that has not been documented in the Susitna River, but may occur in the upper Susitna drainage, is lake trout. Lake trout have been observed in Sally Lake and Deadman Lake of the upper Susitna watershed (Delaney et al. 1981a) but have not been observed in the mainstem Susitna or tributary streams. Pacific lamprey have been observed in the Chuit River (Nemeth et al. 2010), which also drains into Cook Inlet. Northern pike is an introduced species that has been observed in the lower and middle river (Rutz 1999, Delaney et al. 1981b). Although it is considered unlikely that Pacific lamprey and northern pike are present in the Upper Susitna, this study will be helpful for evaluating these species' distributions.

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

Specific information needs relative to fish distribution and abundance in the Upper Susitna River that were identified in the ARDGA (AEA 2011b) include:

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

Little is known about the density and distribution of juvenile salmon in the Susitna River upstream of the proposed dam site at RM 184. Pacific salmon (all five species) were captured in the lower and middle Susitna River during the 1980s. Chinook salmon are the only anadromous species known to occur in the upper Susitna River and tributaries although the information on the extent of their distribution is limited. In the 1980s, adult Chinook salmon were observed in Cheechako, Chinook, Devil and Fog Creeks (ADF&G 1985). More recent sampling documented adults in Fog Creek, Tsusena and Kosina creeks and also documented juvenile Chinook salmon in Fog Creek, Kosina Creek and in the Oshetna River (Buckwalter 2011). Coho, chum, sockeye, and pink salmon were found in the lower and middle Susitna River during the 1980s but have not been observed upstream of Devils Canyon.

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

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

Site-specific knowledge of the distribution, timing, and abundance of fish likely to occupy the proposed Watana Reservoir primarily depends on the results of surveys conducted by ADF&G during the early 1980s using multiple sampling methods (AEA 2011a). The existing information can provide a starting point for understanding the distribution and abundance of anadromous and resident freshwater fishes in the Susitna River and the functional relationship with the habitat types present. However, any significant differences in the patterns in abundance and distribution observed during the 1980s compared to current conditions need to be determined.

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

- Instream Flow Study (Section 6.5) – Fish collections will help to validate fish periodicity, habitat associations, and selection of target species for reach-specific analyses.
- Salmon Escapement and Early Life History Study (Section 7.7) - Patterns of distribution and abundance from traditional sampling methods will help to validate and complement information from radio telemetry observations of Chinook salmon.
- Fish Harvest Study (Section 7.15) – Fish distribution and abundance will complement information about harvest rates and effort expended by commercial, sport, and subsistence fisheries.

- Characterization of Aquatic Habitats (Section 7.9) – Fish collections and observations in conjunction with aquatic habitat characterization will aid in the development of fish and habitat associations (Escapement Study and Instream Flow Study).
- Groundwater-related Aquatic Habitat Study (Section 5.7) – Fish observations and collections will aid in the identification of important groundwater habitats.
- Fish Passage Barriers Study (Section 7.12) – Fish collections will provide data on fish use in sloughs and tributaries with seasonal flow-related or permanent fish barriers.
- River Productivity Study (Section 7.8) – Fish collections and observations will help to characterize relative abundance, size-at-age, condition of fish, and contribution of marine-derived nutrients, which are important for estimating overall river productivity.

7.5.3. Study Area

The study area encompasses the mainstem Susitna River from Devils Canyon (RM 150) up to the Oshetna River confluence (RM 233.4) (Figure 7.5-1). The upper Susitna River is further delineated by the location of the proposed Watana Dam at RM 184 because effects of the Project are anticipated to be different upstream and downstream of the proposed dam. The mainstem Susitna River and its tributaries upstream of the proposed dam will be within the impoundment zone and subject to Project operations that affect daily, seasonal, and annual changes in pool elevation plus the effects of initial reservoir filling. In contrast, the mainstem downstream of the Project will be subject to the effects of flow modification from Project operations. Tributary surveys upstream of the proposed Watana Dam are further delineated by the 3,000 foot elevation contour and are based on the known extent of juvenile Chinook salmon distribution. Some study components, such as resident fish life-history studies and juvenile Chinook salmon distribution sampling, may extend beyond the core area.

7.5.4. Study Methods

This study will employ a variety of field methods to build upon the existing information related to the distribution and abundance of fish species in the Upper Susitna River. The following sections provide brief descriptions of the suite of methods that will be used to accomplish each objective of this study. This study was initiated in 2012 and will continue over the next two years to survey as much habitat as possible.

The study utilizes two approaches for obtaining key life history information about the fish that inhabit the Susitna River. The first approach uses passive and active methods to capture fish throughout the year at a variety of locations in the Susitna River upstream of Devils Canyon. The second method utilizes biotelemetry, including radio-tracking and PIT tags, to monitor the movements and habitat utilization of individuals.

7.5.4.1. Passive and Active Sampling

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

- If it can be conducted safely, snorkeling, electrofishing, and gill netting will require nighttime sampling in clear-water areas to increase the efficacy of fish capture or observation;
- Gill netting is likely the most effective means of capturing fish in open-water areas of the main Susitna River channel;
- All fish sampling and handling techniques described within this study will be conducted under state and federal biological collection permits, and state and federal regulatory agencies will grant permission to conduct the sampling efforts. Limitations on the use of some methods during particular time periods or locations may affect the ability to make statistical comparisons among spatial and temporal strata;
- Fish sampling techniques provide imperfect estimates of habitat use and relative fish abundance. Use and comparison of multiple sampling methods provides the opportunity to identify potential biases, highlight strengths and weaknesses of each method, and ultimately improve estimates of fish distribution and relative abundance; and
- Sampling in the reservoir inundation zone will be scaled based on elevation and Chinook salmon distribution. More intensive surveys will be conducted in tributaries to be inundated up to elevation of 2,200 feet. Sampling from 2,200 feet to 3,000 feet elevation will be focused on Chinook salmon. If Chinook salmon are located, sub-sampling will continue upstream to the upper extent of suitable Chinook salmon habitat.

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

The work effort for active and passive fish sampling is divided into 10 methods, as described below.

Gill Net Sampling

Deploy variable mesh gill nets (7.5-foot long panels with 1-inch to 2.5-inch stretched mesh) approximately once per month during the ice-free months of 2013 and 2014, except August, when two sampling events will occur. In open water and at sites with high water velocity, gill nets will be deployed as drift nets, while in slow water sloughs, gill nets will be deployed as set (fixed) nets. Depending on conditions, gill nets may be deployed in ice-free areas, and under the ice during winter months. The location of each gill net set will be mapped using handheld GPS units and marked on high-resolution aerial photographs. The length, number of panels, and mesh of the gill nets will be consistent with nets used by ADF&G to sample the river in the 1980s (ADF&G 1982, ADF&G 1983, ADF&G 1984).

Electrofishing

Conduct monthly, boat-mounted, barge, or backpack electrofishing surveys using standardized transects). Boat-mounted electrofishing is the most effective means of capturing fish in shallow areas (<10 feet deep) near stream banks and within larger side channels. Barge-mounted electrofishing is effective in areas that are wadeable, but have relatively large areas to cover and are too shallow or inaccessible to a boat mounted system. Backpack electrofishing is effective in wadeable areas that are relatively narrow. The effectiveness of barge and backpack electrofishing systems can be enhanced through the use of block nets. In all cases the electrofishing unit will be operated and configured with settings consistent with guidelines established by ADF&G. The location of each electrofishing transect will be mapped using handheld GPS units and marked on high-resolution aerial photographs.

Selection of the appropriate electrofishing system will be made as part of site selection, which will include a site reconnaissance and be determined in collaboration with the Fish and Aquatic Technical Workgroup. To the extent possible, the selected electrofishing system and transects will be standardized and the methods will be repeated during each sampling period at a specific site to evaluate temporal changes in fish distribution. Habitat measurements will be collected at each site using the characterization methods identified in Section 7.9. Any changes will be noted between sample periods. The electrofishing start and stop times will be recorded and the river water surface elevation relative to an arbitrary benchmark will be measured using a hand level. Where safety concerns can be adequately addressed, electrofishing will also be conducted after sunset in clear water areas; otherwise electrofishing surveys will be conducted during daylight hours.

Angling

During field trips organized for other sampling methods, hook-and-line angling will be conducted on an opportunistic basis using artificial lures or flies with single barbless hooks. The primary objective of hook and line sampling will be to capture subject fish for tagging and to determine presence/absence; a secondary objective will be to evaluate seasonal fish distribution.

Trot Lines

Trot lines can be an effective method for capturing burbot, rainbow trout, Dolly Varden, grayling, and whitefish. Trot lines can also be used during periods of winter ice cover. Trot line sampling was one of the more frequently used methods during the 1980s and was the primary method for capturing burbot. Trot lines will consist of 14 to 21 feet of seine twine with 6 leaders and hooks lowered to the river bottom. Trot lines will be checked and rebaited after 24 hours and pulled after 48 hours. Hooks will be baited with salmon eggs, herring, or whitefish. Salmon eggs are usually effective for salmonids, whereas the herring or whitefish are effective for burbot. Trot line construction and deployment will follow the techniques used during the 1980s studies as described in ADF&G (1982).

Minnow Traps

During the 1980s, minnow traps were the primary method used for capturing sculpin, lamprey, and threespine stickleback. Minnow traps also captured rainbow trout and Arctic grayling. Minnow traps will be baited with salmon roe, checked and rebaited after 24 hours, and pulled after 48 hours. Between 5 and 10 minnow traps will be deployed, depending upon the size of the sampling site.

Snorkeling

Two experienced biologists will conduct snorkel surveys along standardized transects in clear water areas during both day and night during each field survey effort. Snorkelers will visually identify and record the number of observed fish by size and species. The location of each snorkel survey transect will be mapped using handheld GPS units and marked on high resolution aerial photographs.

Fyke/Hoop Nets

Fyke or hoop nets will be deployed to collect fish in sloughs and side channels with moderate water velocity (< 3 feet per second). After a satisfactory location has been identified at each site, the same location will be used during each subsequent collection period. The nets will be operated continuously for a two-day period. Each fyke net will be configured with two wings to guide the majority of water and fish to the net mouth. Where possible, the guide nets will be configured to maintain a narrow open channel along one bank. Where the channel size or configuration does not allow an open channel to be maintained, the area below the fyke net will be checked regularly to assess whether fish are blocked and cannot pass upstream. A live car will be located at the downstream end of the fyke net throat to hold captured fish until they can be processed. The fyke net wings and live car will be checked daily to clear debris and to ensure that captured fish do not become injured. The location of the fyke net sets will be mapped using a handheld GPS unit and marked on high-resolution aerial photographs.

Beach Seine

Beach seines are suitable in shallow water areas free of large woody debris and snags such as boulders. Beach seines will be 6 feet in depth and 75 feet in length; however, the actual length of seine used will depend on the site conditions. The location fished will be mapped using handheld GPS units and marked on high resolution aerial photographs. The area swept will be noted. To the extent possible, the same area will be fished during each sampling event.

Outmigrant Trap

Rotary screw traps and inclined plane traps are useful for determining the timing of emigration by downstream migrating juvenile salmonids and resident fish (Objective 6). One site located near the proposed Watana Dam will be selected for an outmigrant trap. Selection of rotary screw traps or inclined plane traps and the location will occur in collaboration with the Fish and Aquatic TWG and be based on the physical conditions at the selected sites and logistics for deploying, retrieving, and maintaining the traps. Flow conditions permitting, traps will be fished on a cycle of 48 hours on, 72 hours off throughout the ice-free period.

DIDSON and Video Cameras

DIDSON and video cameras are proposed to survey up to 10 selected sloughs and side channels during the winter period. The sloughs will be the same as those selected for the winter-time deployment of PIT tag antennas. The deployment techniques will follow those described by Mueller et al. (2006). DIDSON and/or video cameras will be lowered through auger holes drilled through the ice to make 360 degree surveys. Mueller et al. (2006) found that DIDSON cameras were useful for counting and measuring fish up to 52.5 feet (16 meters) from the camera and were effective in turbid waters. In contrast, they found that video cameras were only effective in clear water areas with turbidity less than 4 NTU. However, Mueller et al. (2006) noted that identifying species and observing habitat conditions were more effective with video cameras than DIDSON cameras. In addition to fish observations, video cameras will also be used to characterize winter habitats attributes such as the presence of anchor ice, hanging dams, and substrate type.

Fish Handling

Field crews will record the date, start and stop times, and level of effort for all sampling efforts as well as water temperature and dissolved oxygen at sampling locations. With the exception of snorkeling, all captured fish will be identified to species, measured to the nearest millimeter (mm) total length, and weighed to the nearest gram. The presence/absence of northern pike and other invasive fish species will be documented in all samples (Objective 7). For snorkeling, all fish observed will be identified to species and total length will be estimated within 40 millimeter bin sizes. If present, observations of poor fish condition, lesions, external tumors, or other abnormalities will be noted. When more than 30 fish of a similar size class and species are collected at one time, the total number will be recorded and a subset of the sample will be measured and weighed to provide at least 30 measurements for each species and size class. To meet Objective 5, all juvenile salmon, rainbow trout, Arctic grayling, Dolly Varden, burbot, longnose sucker, and whitefish greater than 60 mm in length will be scanned for passive integrated transponder (PIT) tags using a portable tag reader. A PIT tag will be implanted into all fish of these species that do not have tags and are approximately 60 mm and larger.

Otoliths will be collected from Dolly Varden and humpback whitefish greater than 200 mm (7.8 inches) in length to test for marine derived elements indicative of an anadromous life history pattern (Objective 2). We assume that larger fish are more likely to have exhibited anadromy and therefore propose otolith collection only from fish greater than 200 mm. A target of 30 fish of each species during 2013 and 2014 will be collected (60 fish of each species total).

Tissue samples will be collected from selected resident and non-salmon fish to support the Genetic Baseline Study (Objective 3; Section 7.14). The target number of samples, species of interest, and protocols are outlined in Section 7.14. Tissue or whole fish samples will also be collected in the mainstem Susitna River for assessment of metals concentrations (Objective 4) (see *Mercury Assessment and Potential for Bioaccumulation Study*, Section 5.12). The number of fish per species or species assemblage and the handling protocols will be determined in coordination with the Fish and Aquatics TWG and the Subsistence group for species consumed by humans and the Wildlife TWG for piscivorous furbearers and birds.

7.5.4.2. Remote Fish Telemetry

Remote telemetry techniques will include radiotelemetry and PIT tags. Each of these methods is intended to provide detailed information from relatively few individual fish. Radio-tracking provides information on fine and large spatial scales related to the location, speed of movement, and habitat utilization by surveying large areas and relocating tagged individuals during aerial, boat, and foot surveys. PIT tags can be used to document relatively localized movements of fish as well as growth information from tagged individuals across seasons and years. However, the "re-sighting" of PIT-tagged fish is limited to the sites where antenna arrays are placed. To determine movement in and out of side-sloughs or tributaries requires that tagged fish pass within several feet of an antenna array, thereby limiting its use to sufficiently small water bodies. To characterize growth rates, fish must be recaptured, checked for a tag, and measured.

7.5.4.2.1. Radiotelemetry

Re-location data from the radio-telemetry component of this study will characterize timing and degree of movements among macrohabitats. Radio-tagged fish provide information on a much greater spatial scale than PIT tags, but potentially less on a temporal scale.

Radio transmitters will be surgically implanted in up to 30 fish of sufficient body size of each species in the Upper River. These fish will be captured during sampling events, with the spatial and temporal allocation of fish being determined based on input from the Fish and Aquatic TWG and after the 2012 study results are available (i.e., preliminary fish abundance and distribution). The tag's signal pulse duration and frequency, and, where appropriate, the transmit duty cycle, will be a function of the life history of the fish and configured to maximize battery life and optimize data collection. Large tags will provide the greatest duration and will be used when possible. Duty cycles can be programmed to enable the tag to be dormant for periods when surveys will not be conducted and greatly extend tag life.

Locating radio-tagged fish will be achieved by fixed receiver stations and aerial surveys. With input from the TWG, up to four fixed receivers will be established at tributary mouths along the mainstem of the Upper Susitna River and serviced in conjunction with the Salmon Escapement Study. These fixed stations will be downloaded as power supplies necessitate and up to twice monthly during the salmon spawning period (approximately July through October). The Salmon Escapement Study will provide approximately weekly aerial survey coverage of the study area. At other times of the year, the frequency of aerial surveys will be at least monthly. Spatial and temporal allocation of survey effort will be finalized based on the actual locations and number of each species of fish tagged, and input from the TWG.

7.5.4.2.2. PIT Tag Antenna Arrays

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

PIT tag antenna arrays with automated data logging will be used at selected side channel, side slough, and upland slough sites to detect movement of tagged fish into or out of the site. A variety of antenna types may be used including hoop antennas, swim-over antennas, single rectangle (swim-through) antennas, or multiplexed rectangle antennas to determine the directionality of movement.

Up to six sites will be selected for deploying PIT tag antenna arrays. AEA will work collaboratively with the Fish and Aquatic TWG to select the sites for antenna deployment. Antennas will be deployed shortly after ice-off in 2013. Data loggers will be downloaded every two to four weeks depending upon the need to replace batteries and reliability of logging systems. Power to the antennas will be supplemented with solar panels.

On an experimental basis, swim-over antennas will be deployed at three sites prior to ice-over and maintained throughout the winter months. Downloading of data and battery replacement every three to four weeks, weather permitting, will be the objective during the winter months.

Depending upon the success at these three sites during the winter of 2012-2013, winter deployment of antennas may be expanded during the following two study years.

7.5.5. Consistency with Generally Accepted Scientific Practices

This study plan was developed by fisheries scientists in collaboration with the Fish and Aquatic TWG and draws upon a variety of methods including many that have been published in peer reviewed scientific journals. As such, the methods chosen to accomplish this effort are consistent with standard techniques used throughout the fisheries scientific community. However, logistical and safety constraints inherent in fish sampling in a large river in northern latitudes also play a role in selecting appropriate methodologies. In addition, some survey methods may not be used in the mainstem river immediately upstream of Devils Canyon to avoid any risk of being swept into the canyon. During the 1980s studies, no surveys were conducted on the mainstem river from RM 150 to RM 189.0, except for spawning surveys conducted by helicopter.

7.5.6. Schedule

The proposed schedule for the completion of the Study of Fish Distribution and Abundance in the Upper Susitna River is:

- Selection of study sites – January – March 2013
- Open water fieldwork – May to October 2013 and May to October 2014
- Ice-over fieldwork – December to April 2013-2014 and December to April 2014-2015
- Reporting of interim results – September 2013 and 2014.
- QC'd geospatially-referenced relational database – December 2013 and 2014.
- Data analysis – October to December 2013 and October to December 2014
- Initial and Revised Study Reports on 2013 and 2014 activities – December 2013 and 2014, respectively.
- Supplemental memorandum on winter 2014-2015 activities – May 2015

7.5.7. Level of Effort and Cost

This is a multiyear study that will begin in early 2013 and end in March 2015. The study will include three winter periods and two ice-free periods. Sampling will be conducted according to a stratified scheme designed to cover a range of habitat types. Stratification for mainstem sites will be based on the five major habitat types: main channel, side channel, tributary mouth, side slough, and upland slough. To evaluate variability within the strata, five sites for each habitat type will be selected for the mainstem river (25 sites). Sampling frequency at each site will vary from month to month:

- December to April – 2 sampling events
    - 3 sites per habitat type for the mainstem river
    - DIDSON, video, gill nets, minnow traps, and trot lines only
- May – 1 sampling event
- June – 1 sampling event
- July – 1 sampling event
- August – 2 sampling events

- September – 1 sampling event
- October/November - No Sampling

Stratification of habitats to be sampled in tributary streams will include pools, runs, and backwaters (if present). Selection of sampling sites will be influenced by the results of the tributary habitat mapping and fish sampling conducted by AEA during 2012, which may indicate some tributaries are unsuitable for sampling because of safety issues or passage barriers. A number of tributaries will be selected in consultation with the Fish and Aquatic TWG. Some tributaries to be considered include:

- Fog Creek,
- Unnamed northern tributary about one mile downstream of Tsusena Creek,
- Tsusena Creek,
- Deadman Creek,
- Unnamed northern tributary between Deadman Creek and Watana Creek,
- Watana Creek,
- Unnamed southern tributary downstream from Kosina Creek,
- Kosina Creek,
- Jay Creek,
- Unnamed Southern tributary between Jay and Goose Creek,
- Unnamed Northern tributary downstream from Oshetna Creek,
- Goose Creek, and
- Oshetna River.

Eight tributary streams will be targeted for sampling during 2013 and 2014. All tributaries in which Chinook salmon juveniles or adults were observed within or at the mouth of a tributary during 2012 or previous surveys by Buckwalter (2011) (i.e., Fog Creek, Kosina Creek, Tsusena Creek, Oshetna River) will be sampled. The remaining tributaries that are suitable for sampling will be selected at random. For each selected tributary stream, up to three habitat types (pool, riffle, backwater) will be selected at random for sampling. Specific sampling methods from those described above will be selected based upon the habitat conditions. To the extent possible, the same sampling methods will be used during all sampling events for a particular site. Physical habitat measurements (length, width, habitat type, photographs) will be collected at all sites sampled.

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

7.5.8. Literature Cited

ADF&G (Alaska Department of Fish and Game). 1982. Aquatic Studies Procedures Manual: Phase I. Su-Hydro Aquatic Studies Program. Anchorage, Alaska. 111 pp.

ADF&G (Alaska Department of Fish and Game). 1983. Aquatic Studies Procedures Manual: Phase II - Final Draft 1982-1983. Alaska Department of Fish and Game. Su-Hydro Aquatic Studies Program. Anchorage, Alaska. 257 pp.

ADF&G (Alaska Department of Fish and Game). 1984. ADF&G Su Hydro Aquatic Studies May 1983 - June 1984 Procedures Manual Final Draft. Alaska Department of Fish and Game. Su-Hydro Aquatic Studies Program. Anchorage, Alaska.

AEA (Alaska Energy Authority). 2011a. Pre-application Document (PAD): Susitna-Watana Hydroelectric Project FERC Project No. 14241. December 2011. Prepared for the Federal Energy Regulatory Commission, Washington, DC.

AEA. 2011b. Aquatic Resources Gap Analysis. Prepared by HDR, Inc., Anchorage. 107 pp.

Delaney, K., D. Crawford, L. Dugan, S. Hale, K Kuntz, B. Marshall, J. Mauney, J. Quinn, K. Roth, P Suchanek, R. Sundet, and M. Stratton. 1981a. Resident Fish Investigation on the Upper Susitna River. Alaska Department of Fish and Game, Anchorage, AK. 157 pp.

FERC (Federal Energy Regulatory Commission). 1984. Draft environmental impact statement: Susitna Hydroelectric Project. Appendices H and I, Volume 4. Applicant: Alaska Power Authority, Anchorage, Alaska.

Mueller, R.P., R.S. Brown, H. Hop, and L. Moulton. 2006. Video and acoustic camera techniques for studying fish under ice: a review and comparison. (16):213-226.

NMFS (National Marine Fisheries Service). 2012. Comments of the National Marine Fisheries Service on the Pre-Application Document, Scoping Document 1, Study Requests for the Suistna-Watana Hydropower Project P-14241-000. Letter to Federal Energy Regulatory Commission. May 31, 2012.

Rutz, D.S. 1999. Movements, food availability and stomach contents of Northern Pike in selected Susitna River drainages, 1996-1997. Alaska Department of Fish and Game Fishery Data Series No. 99-5. Anchorage, Alaska. 78 pp.

Schmidt, D.C., S.S. Hale, and D.L. Crawford. 1985. Resident and juvenile anadromous fish investigations (May - October 1984). Alaska Department of Fish and Game, Anchorage, Alaska. 483 pp.

Thompson, F. M., S. Wick, and B. Stratton. 1986. Report No 13., Volume I ,Adult Salmon Investigations: May - October 1985. Alaska Department of Fish and Game, APA Document No 3412, Anchorage, Alaska. 173 pp.

USFWS (United States Fish and Wildlife Service). 2012. Scoping Comments, Recommendations and Study Requests Notice of Intent to File License Applications; Filing of Pre-Application Document; Commencement of Licensing Proceeding and Scoping; Request for Comments on the Pre-Application Document and Scoping Document 1, and Identification of Issues and Associated Study Requests for the Susitna-Watana Project No. 14241-00. Letter to K.D. Bose of the Federal Energy Regulatory Commission. May 31, 2012.

Buckwalter, J.D. 2011. Synopsis of ADF&G's Upper Susitna Drainage Fish Inventory, August 2011. Alaska Department of Fish and Game, Division of Sport Fish, Anchorage, Alaska. 27 pp.

Sautner, J., and M. Stratton. 1983. Upper Susitna River Impoundment Studies 1982. Alaska Department of Fish and Game. Anchorage, Alaska. 220 pp.

7.5.9. Tables

Table 7.5-1. Summary of life history, known Susitna River usage of fish species within the upper Susitna River reaches (Compiled from Delaney et al. 1981).

Common Name	Scientific Name	Life History[a]	Susitna Usage[b]	Distribution[c]
Arctic grayling	*Thymallus arcticus*	F	O, R, P	Low, Mid, Up
Burbot	*Lota lota*	F	O, R, P	Low, Mid, Up
Chinook salmon	*Oncorhynchus tshawytscha*	A	M_2, R	Low, Mid, Up
Dolly Varden	*Salvelinus malma*	A,F	O, P	Low, Mid, Up
Humpback whitefish[d]	*Coregonus pidschian*	A,F	O, R, P	Low, Mid, Up
Lake trout	*Salvelinus namaycush*	F	U	U
Longnose sucker	*Catostomus catostomus*	F	R, P	Low, Mid, Up
Round whitefish	*Prosopium cylindraceum*	F	O, M_2, P	Low, Mid, Up
Sculpin[e]	*Cottid*	M_1, F	P	Low, Mid, Up

[a] A = anadromous, F = freshwater, M_1 = marine

[b] O = overwintering, P = present, R = rearing, S = spawning, U = unknown, M_2 = migration

[c] Low = Lower River, Mid = Middle River, Up = Upper River, U = Unknown

[d] Whitefish species that were not identifiable to species by physical characteristics in the field were called humpback by default. This group may have contained Lake (*Coregonus clupeaformis)*, or Alaska (*Coregonus nelsonii*) whitefish.

[e] Sculpin species generally were not differentiated in the field. This group may have included Slimy (*Cottus cognatus*), Prickly (*Cottus asper)*, Coastal range (Cottus aleuticus), and Pacific staghorn (*Leptocottus armatus*).

7.5.10. Figures

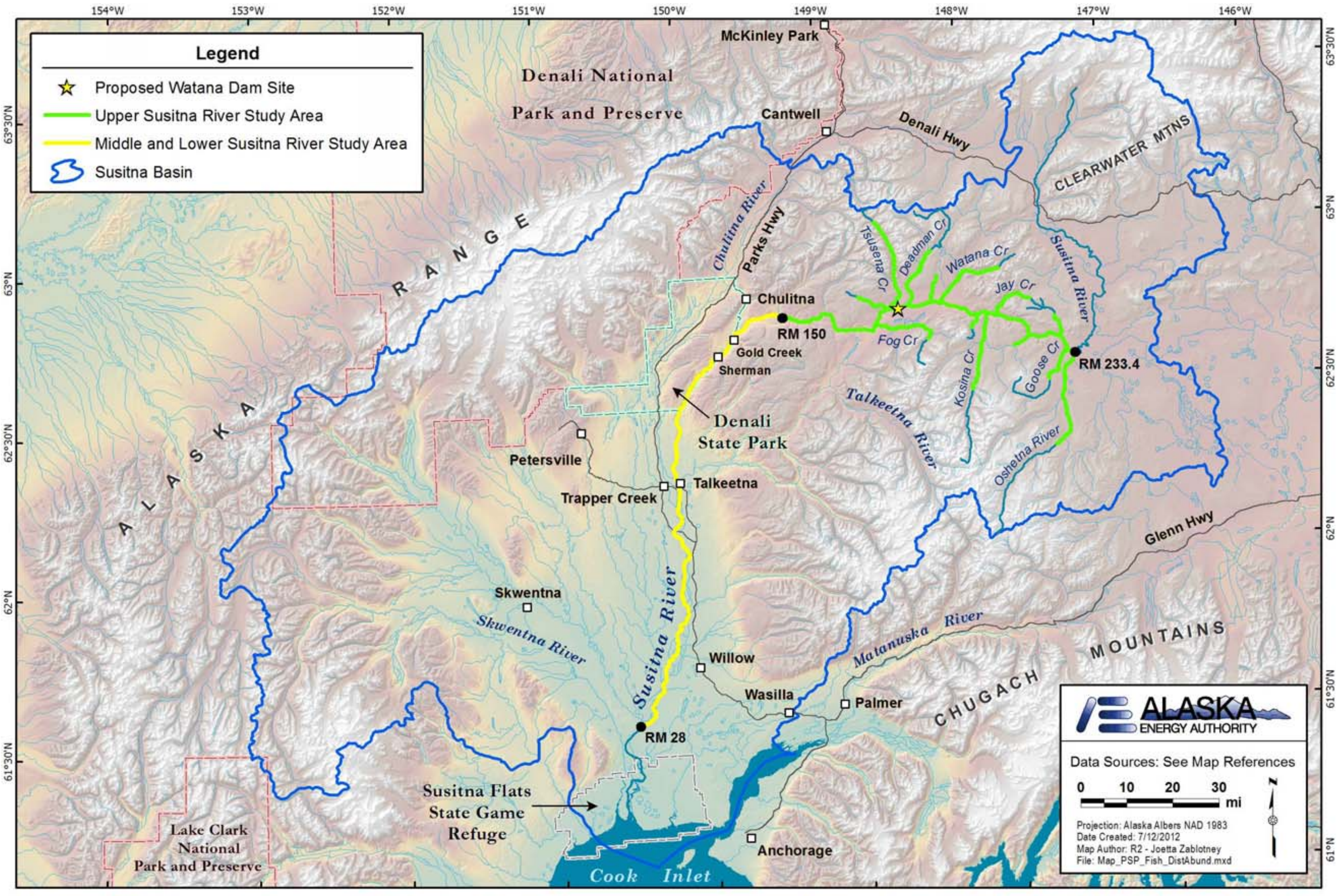


Figure 7.5-1. Fish distribution and abundance study area.

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

7.6.1. General Description of the Proposed Study

This study is focused on fish species that use the Susitna River downstream of Devils Canyon. Fishery resources in the upper sections of the Susitna River basin consist of a variety of salmonid and non-salmonid resident fish (Table 7.6-1). Adult salmon species are addressed in the Salmon Escapement Study (Section 7.7).

The physical habitat modeling efforts proposed elsewhere in this PSP require information on the distribution and periodicity of different life stages for the fish species of interest. Not all life stages of the target fish species may be present throughout the Middle and Lower Susitna River, and seasonal differences may occur in their use of some habitats. For example, some fish that use tributary streams during the open-water period may overwinter in mainstem habitats such as groundwater-fed sloughs.

This study is designed to provide baseline biological information and supporting information for the Instream Flow Modeling Study (see Section 6.5). This study will obtain key life history information about the fish in Middle and Lower Susitna River using two sampling approaches. The first sampling approach involves active and passive capture methods to identify the seasonal timing, distribution, and abundance of fish at a variety of locations and habitat types downstream of Devils Canyon. The second sampling approach involves biotelemetry to monitor the movements and habitat utilization of tagged fish.

7.6.1.1. Study Goals and Objectives

Construction and operation of the Project will affect flow, water depth, surface water elevation, water temperature, and sediment dynamics, among other variables, in the mainstem channel as well as at tributary confluences, side channels, and sloughs, both in the area of inundation upstream from the Watana Dam site and downstream in the potential zone of Project hydrologic influence. These changes can have beneficial or adverse effects upon the aquatic communities residing in the river. To assess the effects of river regulation on fish populations, an understanding of existing conditions will be needed, providing baseline information for predicting the likely extent and nature of potential changes that will occur due to the Project's effects on flow and temperature regimes.

The overarching goal of this study is to characterize the current distributions, relative abundances, run timings, and life histories of all resident and non-salmon anadromous species encountered including, but not limited to: Bering cisco, Dolly Varden, eulachon, humpback whitefish, northern pike, and Pacific lamprey, and freshwater rearing life stages of anadromous fish (fry and juveniles) in the Middle and Lower Susitna River. Specific objectives include:

1) Describe the seasonal distribution, relative abundance (as determined by CPUE, fish density, and counts), and fish-habitat associations of juvenile anadromous salmonids, non-salmonid anadromous fishes and resident fishes;
2) Describe seasonal movements of selected fish species such as rainbow trout, eulachon, Dolly Varden, whitefish, northern pike, Pacific lamprey, and burbot) using biotelemetry

(PIT and radio-tags) with emphasis on identifying foraging, spawning and overwintering habitats within the mainstem of the Susitna River and its associated off-channel habitat;

3) Document the timing of downstream movement and catch for all fish species using outmigrant traps;
4) Characterize the age structure, growth, and condition of juvenile anadromous and resident fish by season;
5) Document the seasonal distribution, relative abundance, and habitat associations of invasive species (northern pike); and
6) Collect tissue samples from juvenile salmon and opportunistically from all resident and non-salmon anadromous fish to support the Genetic Baseline Study (Section 7.14).

7.6.2. Existing Information and Need for Additional Information

Information regarding resident species, non-salmon anadromous species, and the freshwater rearing lifestages of anadromous salmon was collected as part of the studies conducted during the early 1980s. Existing information includes the spatial and temporal distribution of fish species and their relative abundance. The PAD (AEA 2011a) and Aquatic Resources Data Gap Analysis (ARDGA; AEA 2011b) summarized this existing information and also identified data gaps for resident and rearing anadromous fish.

Approximately 18 anadromous and resident fish species have been documented in the Susitna River drainage (Table 7.6-1). Three additional species are considered likely to be present, but have not been documented. To varying degrees, the relative abundances and distributions of these species were determined during the early 1980s studies. For most species, the dominant age classes and sex ratios were also determined, and movements, spawning habitats, and overwintering habitats were identified for certain species. Resident species that have been identified in all three reaches of the Susitna River include Arctic grayling, Dolly Varden, humpback whitefish, round whitefish, burbot, longnose sucker, and sculpin. Other species that were observed in the Middle and Lower reaches include Bering cisco, threespine stickleback, arctic lamprey, and rainbow trout. Eulachon have been documented only in the Lower reach.

Species that have not been documented, but may occur in the Susitna drainage, include lake trout, Alaska blackfish, and Pacific lamprey. Lake trout have been observed in Sally Lake and Deadman Lake of the upper Susitna watershed (Delaney et al. 1981a), but have not been observed in the mainstem Susitna or tributary streams. Pacific lamprey have been observed in the Chuit River (Nemeth et al. 2010), which also drains into Cook Inlet. Northern pike is an introduced species that has been observed in the lower and middle river (Rutz 1999, Delaney et al. 1981b).

Non-salmon species that exhibit anadromous life histories in the Susitna River include eulachon, humpack whitefish, and Bering cisco. Dolly Varden may exhibit both anadromous and resident freshwater life history forms (Morrow 1980); however, Dolly Varden in the Susitna River were regarded primarily as a resident fish during studies conducted in the 1980s (FERC 1984). Other species that can exhibit an anadromous life history include humpback whitefish, threespine stickleback, Arctic lamprey, and Pacific lamprey (Morrow 1980). Northern pike are considered an invasive species in the Susitna drainage and have spread throughout the system from the Yenta drainage after being illegally introduced in the 1950s (Rutz 1999). Alaska blackfish would also be considered an invasive species in this basin, and while not previously captured in the Susitna River, may have been introduced.

Pacific salmon (all five species) were captured in the lower and middle Susitna River during the 1980s. Coho salmon typically outmigrate to sea as age 1+ or age 2+ fish. Because chum and pink salmon outmigrate to sea within a few months of emergence, little is known about their dependence on the Susitna River. Most age 0+ sockeye salmon outmigrate from the middle river. It has not been determined whether they rear in the lower river or if they go to sea at age 0+.

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

- F4: Effect of Project operations on flow regimes, sediment transport, temperature, and water quality that result in changes to seasonal availability and quality of aquatic habitats, including primary and secondary productivity. The effect of Project-induced changes include stream flow, stream ice processes, and channel morphology (streambed coarsening) on anadromous fish spawning and incubation habitat availability and suitability in the mainstem and side channels and sloughs in the middle river above and below Devils Canyon.
- F6: Potential influence of the proposed Project flow regime and the associated response of tributary mouths on fish movement between the mainstem and tributaries within the Middle River Reach.
- F7: Influence of Project-induced changes to mainstem water surface elevations July through September on adult salmon access to upland sloughs, side sloughs, and side channels.
- F8: Potential effect of Project-induced changes to stream temperatures, particularly in winter, changing the distribution of fish communities, particularly invasive northern pike.

Agency staff have also expressed concerns that over time (i.e., 50 years) historic salmon spawning areas downstream of the Watana Dam site may become less productive due to potential changes in habitat conditions, in particular, those areas affected by sediment transport, gravel recruitment, bed mobilization, and embeddedness.

Site-specific knowledge of the distribution, timing, and abundance of fish in the Susitna River is available from the results of surveys conducted by ADF&G during the early 1980s using multiple sampling methods (AEA 2011a). The existing information can provide a starting point for understanding the distribution and abundance of anadromous and resident freshwater fishes in the Susitna River and understanding the functional relationship with the habitat types present. However, any significant differences between current abundance and distribution patterns and those observed during the 1980s need to be documented.

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

- Instream Flow Study (Section 6.5) – Fish collections will help to validate fish periodicity, habitat associations, and selection of target species for reach-specific analyses.
- Salmon Escapement Study (Section 7.7) - Patterns of distribution and abundance from traditional sampling methods will help to validate and complement information from radio telemetry, fishwheel, and sonar observations of salmon.

- Fish Harvest Study (Section 7.15) – Fish distribution and abundance will complement information about harvest rates and effort expended by commercial, sport, and subsistence fisheries.
- Characterization of Aquatic Habitats (Section 7.9) – Fish collections and observations in conjunction with aquatic habitat characterization will aid in the development of fish and habitat associations.
- Eulachon Distribution and Abundance (Section 7.16) – This study is directed towards eulachon, which is an important forage fish for beluga whales.
- Groundwater-related Aquatic Habitat Study (Section 5.7) – Fish observations and collections will aid in the identification of important groundwater habitats.
- Fish Passage Barriers Study (Section 7.12) – Fish collections will provide data on fish use in sloughs and tributaries with seasonal flow-related or permanent fish barriers.

7.6.3. Study Area

The proposed study area encompasses the Susitna River from RM 28 upstream to Devils Canyon (RM 150) (Figure 7.5-1). RM 28 is near the confluence with the Yentna River, approximates the upper extent of tidal influence, and is the lower extent of the Habitat Characterization Study (Section 7.9).

7.6.4. Study Methods

The study involves the use of two approaches for obtaining key life history information about the fish that inhabit the Susitna River. The first approach includes passive and active methods to capture fish throughout the year at a variety of locations in the Susitna River downstream of Devils Canyon. The second method is remote fish telemetry, used to monitor the movements and habitat utilization of individuals. With one exception, the following study methods are consistent with those described in study requests submitted by NMFS (2012) and USFWS (2012). Because of safety issues associated with winter conditions and remote study locations, AEA has decided to not include ice-diving as a proposed method in this study.

7.6.4.1. Passive and Active Sampling

A combination of gill net, electrofishing, angling, trot lines, minnow traps, snorkeling, fishwheels, outmigrant trapping, beach seines, fyke nets, DIDSON, and video camera techniques will be used to sample or observe fish in the Lower River and Middle River, and moving in and out of selected sloughs and tributaries draining into the Susitna River. The methods proposed are similar to those described in Section 7.5.4.1. A few additional methods that may be applicable to the habitats and species in the Middle and Lower River are described below.

7.6.4.1.1. Fishwheels

Fishwheels will primarily be deployed to capture anadromous salmon as part of the Adult Salmon Escapement and Early Life History Study (Section 7.7). However, non-salmon species are occasionally captured by fishwheel. Non-salmon species collected by fishwheel will provide additional data to support the objectives of this study and will be used opportunistically as a source of fish for tagging studies and tissue sampling.

7.6.4.1.2. Outmigrant Traps

Rotary screw traps and inclined plane traps are useful for determining the timing of emigration of downstream migrating juvenile salmonids and resident fish. Two sites within side channels open continuously throughout the ice-free season will be selected for outmigrant traps near Based on 1980 fish distribution data Whiskers Creek offers a potential location for sampling in the middle river. Selection of rotary screw traps or inclined plane traps will occur in collaboration with the Fish and Aquatic TWG and be based on the physical conditions at the selected sites and logistics for deploying, retrieving, and maintaining the traps. Flow conditions permitting, traps will be fished on a cycle of 48 hours on, 72 hours off throughout the ice-free period.

7.6.4.2. Remote Fish Telemetry

Remote telemetry techniques will include radiotelemetry and PIT technology. Each of these methods is intended to provide detailed information from relatively few individual fish. Radio-tracking provides information on fine and large spatial scales related to the location, speed of movement, and habitat utilization by surveying large areas and relocating tagged individuals during aerial, boat, and foot surveys. PIT tags can be used to document relatively localized movements of fish as well as growth information from tagged individuals across seasons and years. However, the "re-sighting" of PIT-tagged fish is limited to the sites where antenna arrays are placed. To determine movement in and out of side-sloughs or tributaries requires that tagged fish pass within several feet of an antenna array, thereby limiting its use to sufficiently small water bodies. To characterize growth rates, fish must be recaptured, checked for a tag, and measured.

7.6.4.2.1. Radiotelemetry

Re-location data from the radio-telemetry component of this study will be used to characterize the timing of use and degree of movements among macrohabitats and over periods during which the radio tags remain active (possibly up to two or three seasons per tagged fish). Actual tag life will be determined by the appropriate tag for the size of the fish available for tagging.

Radio transmitters will be surgically implanted in up to 10 fish of sufficient body size of each species from five habitat types in the middle and lower river. These fish will be captured during sampling events that are described above (Passive and Active Sampling Methods) and below (Level of Effort and Cost). The final spatial and temporal allocation of tags will be determined based on input from the Fish and Aquatic TWG and after 2012 study results are available (i.e., preliminary fish abundance and distribution). The tag's signal pulse duration and frequency, and, where appropriate, the transmit duty cycle, will be a function of the life history of the fish and configured to maximize battery life and optimize the data collection. Larger tags can accommodate the greatest battery life and therefore will be used when fish are large enough, but this will not limit application of tags across a range of body sizes. Duty cycles can be programmed to enable the tag to be dormant for periods when surveys will not be conducted (or fish are expected to overwinter in localized area) and this greatly extends tag life.

Locating radio-tagged fish will be achieved by fixed receiver stations and mobile surveys (aerial, boat, and foot). Fixed stations will largely be those used for the Salmon Escapement Study. In addition, up to five additional fixed stations will be established at strategic locations established during the field sampling and with input from the TWG. These stations will be serviced in conjunction with the Salmon Escapement Study during the July through October period and during dedicated trips outside this period. Fixed stations will be downloaded as power supplies necessitate and up to twice monthly during the salmon spawning period (approximately July through October). The Salmon Escapement Study will provide approximately weekly aerial survey coverage of the study area. At other times of the year, the frequency and location of aerial surveys will be at least monthly. Spatial and temporal allocation of survey effort will be finalized based on the actual locations and number of each species of fish tagged and input from the Fish and Aquatic TWG. Foot and boat surveys will be done as part of the spawning ground and habitat sampling in the Escapement Study.

7.6.4.2.2. PIT Tag Antenna Arrays

As described above, all captured fish 60 mm or larger of selected species will be checked for a PIT tag and tagged if one is not present. Half-duplex PIT tags either 12 mm in length or 23 mm in length will be used, depending upon the size of the fish. Each PIT tag has a unique code that allows for identification of individuals. Recaptured fish will provide information on the distance and time travelled since the fish was last handled and changes in length and weight.

PIT tag antenna arrays with automated data logging will be used at selected side channel, side slough, tributary mouth, and upland slough sites to detect movement of tagged fish into or out of the site. A variety of antenna types may be used including hoop antennas, swim-over antennas, single rectangle (swim-through) antennas, or multiplexed rectangle antennas to determine the directionality of movement.

Up to10 sites will be selected for deploying PIT tag antenna arrays. AEA will work collaboratively with the Fish and Aquatic TWG to select the sites for antenna deployment. Antennas will be deployed shortly after ice-off in 2013. Data loggers will be downloaded every two to four weeks, depending upon the need to replace batteries and reliability of logging systems. Power to the antennas will be supplemented with solar panels.

On an experimental basis, swim-over antennas will be deployed at five sites prior to ice-over and maintained throughout the winter months. Downloading of data and battery replacement every three to four weeks, weather permitting, will be the objective during winter months. Depending upon the success of these five sites during the winter of 2012-2013, winter deployment of antennas may be expanded during the two subsequent winter field seasons.

7.6.5. Consistency with Generally Accepted Scientific Practices

This study plan was developed by fisheries scientists in collaboration with the Fish and Aquatic TWG and draws upon a variety of methods including many that have been published in peer review scientific journals. As such, the methods chosen to accomplish this effort are consistent with standard techniques used throughout the fisheries scientific community. However, logistical and safety constraints inherent in fish sampling in a large river in northern latitudes also play a role in selecting appropriate methodologies. To describe the seasonal distribution, relative abundance, and habitat associations of the various fish species in winter, alternate methods involving snorkel and dive surveys were considered. These alternate methods were dismissed based on safety concerns owing to potentially extreme cold temperatures, remoteness of the sampling locations, and because sampling would most appropriately be conducted at night.

7.6.6. Schedule

The proposed schedule for the completion of the Study of Fish Distribution and Abundance in the Middle and Lower Susitna River is:

- Selection of study sites – January – March 2013
- Open water fieldwork – May to October 2013 and May to October 2014
- Ice-over fieldwork – December to April 2013-2014 and December to April 2014-2015
- Reporting of interim results – September 2013 and September 2014.
- QC'd geospatially-referenced relational database – December 2013 and December 2014.
- Data analysis – October to December 2013 and October to December 2014
- Initial and Final Study Reports on 2013 and 2014 activities – December 2013 and 2014, respectively.
- Supplemental technical memorandum on winter 2014-2015 Activities – May 2015

7.6.7. Level of Effort and Cost

This is a multiyear study that will begin in early 2013 and end in March 2015. The study will include three winter periods and two ice-free periods. Sampling will be conducted according to a stratified sampling scheme designed to cover a range of habitat types. The first level of stratification will be the river sections identified previously. Namely the lower river from RM 28 to RM 98 and the middle river from RM 98 to RM 150. Because the Chulitna and Talkeetna rivers are anticipated to substantially moderate the effects of the proposed Project, sampling effort will be focused more heavily on the middle river. The second stratification level will be the five major habitat types: main channel, side channel, tributary mouth, side slough, and upland slough. To examine variability within the strata, three sites for each habitat type will be selected for the lower river (15 sites) and five sites for each habitat type will be selected for the middle river (25 sites) for a total of 40 sites. Sampling frequency at each site will vary from month to month:

- December to April – 2 sampling events
    - 5 sites per habitat type for middle river section
    - 3 sites per habitat for lower river section
    - DIDSON, video, gill nets, minnow traps, and trot lines only
- May – 1 sampling event
- June – 1 sampling event
- July – 1 sampling event
- August – 2 sampling events
- September – 1 sampling event
- October/November - No Sampling

Total study costs are estimated at $3,000,000.

7.6.8. Literature Cited

ADF&G (Alaska Department of Fish and Game). 1982. Aquatic Studies Procedures Manual: Phase I. Su-Hydro Aquatic Studies Program. Anchorage, Alaska. 111 pp.

ADF&G (Alaska Department of Fish and Game). 1983. Aquatic Studies Procedures Manual: Phase II - Final Draft 1982-1983. Alaska Department of Fish and Game. Su-Hydro Aquatic Studies Program. Anchorage, Alaska. 257 pp.

ADF&G (Alaska Department of Fish and Game). 1984. ADF&G Su Hydro Aquatic Studies May 1983 - June 1984 Procedures Manual Final Draft. Alaska Department of Fish and Game. Su-Hydro Aquatic Studies Program. Anchorage, Alaska.

AEA (Alaska Energy Authority). 2011a. Pre-application Document (PAD): Susitna-Watana Hydroelectric Project FERC Project No. 14241. December 2011. Prepared for the Federal Energy Regulatory Commission, Washington, DC.

AEA. 2011b. Aquatic Resources Gap Analysis. Prepared by HDR, Inc., Anchorage. 107 pp.

Delaney, K., D. Crawford, L. Dugan, S. Hale, K Kuntz, B. Marshall, J. Mauney, J. Quinn, K. Roth, P Suchanek, R. Sundet, and M. Stratton. 1981a. Resident Fish Investigation on the Upper Susitna River. Alaska Department of Fish and Game, Anchorage, AK. 157 pp.

Delaney, K., D. Crawford, L. Dugan, S. Hale, K Kuntz, B. Marshall, J. Mauney, J. Quinn, K. Roth, P Suchanek, R. Sundet, and M. Stratton. 1981b. Resident Fish Investigation on the Lower Susitna River Alaska Department of Fish and Wildlife, Anchorage, AK. 311 pp.

FERC (Federal Energy Regulatory Commission). 1984. Draft environmental impact statement: Susitna Hydroelectric Project. Appendices H and I, Volume 4. Applicant: Alaska Power Authority, Anchorage, Alaska.

Morrow, J.E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Co., Anchorage.

Mueller, R.P., R.S. Brown, H. Hop, and L. Moulton. 2006. Video and acoustic camera techniques for studying fish under ice: a review and comparison. (16):213-226.

Nemeth, M.J., A.M. Baker, B.C. Williams, S.W. Raborn, J. T. Preist, and S.T. Crawford. 2010. Movement and abundance of freshwater fish in the Chuit River, Alaska, May through July 2009. Annual Report, Anchorage, Alaska.

NMFS (National Marine Fisheries Service). 2012. Comments of the National Marine Fisheries Service on the Pre-Application Document, Scoping Document 1, Study Requests for the Suistna-Watana Hydropower Project P-14241-000. Letter to Federal Energy Regulatory Commission. May 31, 2012.

Rutz, D.S. 1999. Movements, food availability and stomach contents of Northern Pike in selected Susitna River drainages, 1996-1997. Alaska Department of Fish and Game Fishery Data Series No. 99-5. Anchorage, Alaska. 78 pp.

Schmidt, D.C., S.S. Hale, and D.L. Crawford. 1985. Resident and juvenile anadromous fish investigations (May - October 1984). Alaska Department of Fish and Game, Anchorage, Alaska. 483 pp.

Thompson, F. M., S. Wick, and B. Stratton. 1986. Report No 13., Volume I ,Adult Salmon Investigations: May - October 1985. Alaska Department of Fish and Game, APA Document No 3412, Anchorage, Alaska. 173 pp.

USFWS (United States Fish and Wildlife Service). 2012. Scoping Comments, Recommendations and Study Requests Notice of Intent to File License Applications; Filing of Pre-Application Document; Commencement of Licensing Proceeding and Scoping; Request for Comments on the Pre-Application Document and Scoping Document 1, and Identification of Issues and Associated Study Requests for the Susitna-Watana Project No. 14241-00. Letter to K.D. Bose of the Federal Energy Regulatory Commission. May 31, 2012.

7.6.9. Tables

Table 7.6-1. Summary of life history, known Susitna River usage, and known extent of distribution of fish species within the lower, middle, and upper Susitna River reaches (From ADF&G 1981 a, b, c, etc.).

Common Name	Scientific Name	Life History[a]	Susitna Usage[b]	Distribution[c]
Alaska blackfish	*Dallia pectoralis*	F	U	U
Arctic grayling	*Thymallus arcticus*	F	O, R, P	Low, Mid, Up
Arctic lamprey	*Lethenteron japonicum*	A,F	O, M_2, R, P	Low, Mid
Bering cisco	*Coregonus laurettae*	A	M_2, S	Low, Mid
Burbot	*Lota lota*	F	O, R, P	Low, Mid, Up
Chinook salmon	*Oncorhynchus tshawytscha*	A	M_2, R	Low, Mid, Up
Chum salmon	*Oncorhynchus keta*	A	M_2, S	Low, Mid
Coho salmon	*Oncorhynchus kisutch*	A	M_2, S, R	Low, Mid
Dolly Varden	*Salvelinus malma*	A,F	O, P	Low, Mid, Up
Eulachon	*Thaleichthys pacificus*	A	M_2, S	Low
Humpback whitefish[d]	*Coregonus pidschian*	A,F	O, R, P	Low, Mid, Up
Lake trout	*Salvelinus namaycush*	F	U	U
Longnose sucker	*Catostomus catostomus*	F	R, P	Low, Mid, Up
Northern pike	*Esox lucius*	F	P	Low, Mid
Pacific lamprey	*Lampetra tridentata*	A,F	U	U
Pink salmon	*Oncorhynchus gorbuscha*	A	M_2, R	Low, Mid
Rainbow trout	*Oncorhynchus mykiss*	F	O, M_2, P	Low, Mid
Round whitefish	*Prosopium cylindraceum*	F	O, M_2, P	Low, Mid, Up
Sculpin[e]	*Cottid*	M_1[f], F	P	Low, Mid, Up
Sockeye salmon	*Oncorhynchus nerka*	A	M_2, S	Low, Mid
Threespine stickleback	*Gasterosteus aculeatus*	A,F	M_2, S, R, P	Low, Mid

[a] A = anadromous, F = freshwater, M_1 = marine

[b] O = overwintering, P = present, R = rearing, S = spawning, U = unknown, M_2 = migration

[c] Low = Lower River, Mid = Middle River, Up = Upper River, U = Unknown

[d] Whitefish species that were not identifiable to species by physical characteristics in the field were called humpback by default. This group may have contained Lake (*Coregonus clupeaformis)*, or Alaska (*Coregonus nelsonii*) whitefish.

[e] Sculpin species generally were not differentiated in the field. This group may have included Slimy (*Cottus cognatus*), Prickly (*Cottus asper)*, Coastal range (Cottus aleuticus), and Pacific staghorn (*Leptocottus armatus*).

[f] Pacific staghorn sculpin were found in fresh water habitat within the Lower Susitna River Reach.

7.7. Salmon Escapement Study

7.7.1. General Description of the Proposed Study

Information from this salmon escapement study will be used in combination with other studies to assess potential effects of the proposed Project on fisheries resources. Construction and operation of the Project will modify the flow, thermal, and sediment regimes of the Susitna River, which may alter the composition and distribution of fish. This study will provide a basis for impact assessment and developing potential protection, mitigation, and enhancement measures, including resource management and monitoring plans. This study will provide information on the distribution and abundance of adult salmon in the lower, middle, and upper Susitna River. This work will be conducted through collaboration between AEA, the Alaska Department of Fish and Game (ADF&G), and other relicensing participants. Information developed in this study may also be used to develop any necessary protection, mitigation, or enhancement measures to address Project impacts to salmonid resources.

7.7.1.1 Study Goals

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

7.7.1.2 Study Objectives

1. Capture, radiotag, and track adults of five species of Pacific salmon in the middle and upper Susitna River in proportion to their abundance. Capture and tag Chinook and coho salmon in the lower Susitna River.
2. Characterize the migration behavior and spawning locations of radiotagged fish in the lower, middle, and upper Susitna River.
3. Characterize adult salmon migration behavior and timing within and above Devils Canyon.
4. If shown to be an effective sampling method during the 2012 study, and where feasible, use sonar to document salmon spawning locations in turbid water in 2013 and 2014.
5. Compare historical and current data on run timing, distribution, relative abundance, and specific locations of spawning and holding salmon.
6. Generate counts of adult Chinook salmon spawning in the Susitna River and its tributaries.
7. Collect tissue samples to support the Fish Genetic Baseline Study (Section 7.14).

8. Estimate system-wide Chinook and coho salmon escapement to the Susitna River and the distribution of those fish among tributaries of the Susitna River.

7.7.2. Existing Information and Need for Additional Information

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

- **F2:** Potential effect of fluctuating reservoir surface elevations on fish access and movement between the reservoir and its tributaries and habitats.
- **F3:** Potential effect of Watana Dam on fish movement.
- **F4:** Effect of Project operations on flow regimes, sediment transport, temperature, and water quality that result in changes to seasonal availability and quality of aquatic habitats, including primary and secondary productivity. The effect of Project-induced changes include stream flow, stream ice processes, and channel morphology (streambed coarsening) on anadromous fish spawning and incubation habitat availability and suitability in the mainstem and side channels and sloughs in the middle river above and below Devils Canyon.
- **F5:** Potential effect of Project flow regime on anadromous fish migration above Devils Canyon. Devils Canyon is a velocity barrier to most fish movement and changes in flows can result in changes in the potential fish movement through this area (approximately RM 150).
- **F6:** Potential influence of the proposed Project flow regime and the associated response of tributary mouths on fish movement between the mainstem and tributaries within the Middle River reach.
- **F7:** Influence of Project-induced changes to mainstem water surface elevations July through September on adult salmon access to upland sloughs, side sloughs, and side channels.
- **F8:** Potential effect of Project-induced changes to stream temperatures, particularly in winter, changing the distribution of fish communities, particularly invasive northern pike.

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

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

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

At this time, it is unknown if Chinook salmon spawn upstream of Devils Canyon on an annual basis or if Chinook salmon spawn in the mainstem of the Susitna River below the proposed dam site. The studies will determine where Chinook salmon spawn within the Susitna drainage and quantify the escapement of Chinook salmon that spawn upstream of Devils Canyon as well as the number of Chinook salmon that spawn in the mainstem downstream of the proposed dam. Finally, these studies would assess the Chinook salmon production from the upper river relative to the entire Susitna drainage.

This study will also improve knowledge of the run timing and distribution of spawning Chinook and coho salmon in the Susitna River drainage. Finally, this study will aid in determining how well annual helicopter aerial escapement surveys of select Susitna River tributaries index and monitor trends in escapement of Susitna River Chinook salmon.

7.7.3. Study Area

The study area encompasses the Susitna River from Cook Inlet upstream to the Oshetna River, or as far upstream as Chinook salmon are detected (Figure 7.7-1), with an emphasis on wherever salmon spawn in the middle and upper river. The mainstem Susitna River is divided into two generalized reaches for the purposes of this study plan: the middle river (RM 98 -150) and upper river (RM 150 - 234). Devils Canyon extends from approximately RM 150 to RM 154.

7.7.4. Study Methods

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

7.7.4.1 Objective 1: Capture, radiotag, and track adults of five species of Pacific salmon in the middle and upper Susitna River in proportion to their abundance. Capture and tag Chinook and coho salmon in the lower Susitna and Yentna rivers.

Tasks to address Objective 1 include the following:

- Install and operate two fishwheels at approximately RM 30 of the Susitna and two fishwheels on the lower Yentna River from late May through August, 2013 and 2014.
- Install and operate two fishwheels at Curry (RM 120) from early June to early September in 2013 and 2014 (Figure 1).
- Radiotag a total of 400 Chinook salmon and 400 coho salmon in the lower Susitna (RM 30) and Yenta rivers.
- Radiotag 400 Chinook salmon and 200 each of chum, sockeye, pink, and coho salmon at Curry (RM 120).
- Assess the degree to which radiotagged fish are representative of all salmon passing the tagging sites (e.g., test for size selectivity, compare mark rates among spawning areas).
- Evaluate the potential for handling-induced changes in fish behavior based on the post-release survival and migration rates of radiotagged fish.

Meeting the goals of this study requires that the radiotagged fish of each species are representative of each species' "population" in the middle river. Tagging particular stocks and/or sizes of fish at different rates than others will weaken inferences about relative distribution among tributaries, habitat uses of the middle river such as the relative distribution of spawning fish, migratory behaviors, and any fish passage above Devils Canyon. There are multiple ways to assess whether fish passing the tagging sites are equally vulnerable to being radiotagged. Of greatest importance is to survey spawning areas to determine the size composition of tagged and untagged fish (size distributions) and determine the proportion of fish in different areas that contain a tag (i.e., the mark rate). Statistically significant differences in mark rates among areas would suggest unequal vulnerability; differences in the size distributions of the marked and unmarked fractions of the fish would suggest size-selective capture and tagging.

7.7.4.1.1 Fish Capture

Fishwheels will be used to capture adult salmon for tagging. Two fishwheels will be operated at approximately RM 30 in locations they were fished in 2010-12. Two fishwheels will be operated on the lower Yentna during a similar period, and in the same locations as have been operated for three decades. Two fishwheels will also be operated in 2013 and 2014 near Curry (RM 120) at the same locations in 1981-85 and 2012, from the first week of June through the first week of September. The fishwheels consist of aluminum pontoons, three baskets, and two partially submerged live tanks for holding fish in river water. A tower and winch assembly will be used to adjust the height of the baskets and ensure that the baskets are fishing within 20 cm of the river bottom. Net leads will be installed between fishwheels and the adjacent riverbank to direct fish away from the bank and into the path of the fishwheel baskets. Fishwheels will be operated 12 hours per day. A two-person crew will staff the fishwheels during operations; when the crew is to be absent from the fishwheel for more than 1 hour, the fishwheel baskets will be raised from the water and stopped.

Fishwheel effectiveness, expressed as a fraction of the passing salmon run it captures, often varies within and among seasons. Also known as the catchability coefficient, effectiveness changes with water depth under the fishwheel and water velocity around the fishwheel. The overall abundance of fish in the river at any one time may also affect effectiveness. Variable effectiveness within a season is most problematic for a study of this nature if it varies across the period of the annual run of a particular species and less problematic if it varies across species. Fish later or earlier within a run of a particular species can represent fish of different sizes, ages, and ultimately, fish bound for different habitats. Therefore, stable effectiveness across time, body size, and spawning destination are ideal, and these are assumptions that will need to be tested by appropriate data collection at the fishwheels and surveys of spawning areas. If sufficiently large numbers of fish can be tagged and later examined, any changes in effectiveness can be compensated for by stratification of results.

7.7.4.1.2 Radiotagging

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

Only uninjured fish that meet or exceed a specific length threshold will be radiotagged; i.e., Chinook salmon with a mid-eye to fork length (METF) of ≥ 500 millimeters; coho, sockeye, and chum salmon ≥ 400 millimeters; and pink salmon ≥ 325 millimeters. These size thresholds proposed for coho, sockeye, and chum salmon are similar to those used by ADF&G (Yanusz et al. 2011; Merizon et al. 2010). The Chinook salmon length threshold coincides with all ocean-age 3 fish and a to-be-determined portion of ocean-age 2 fish. All fish to be tagged will be placed in a water-filled, foam-lined, V-shaped trough. To minimize handling time (i.e., achieve < 1 minute per fish) and tagging-related effects on fish behavior, anesthetic will not be used. Radio tags will be inserted orally into the stomach of the fish using a piece of PVC tubing (1/3 inch diameter and 18 inches long) with the tag antenna left to protrude from the mouth. No external marks will be applied to radiotagged fish.

All radiotagged salmon will be measured to determine mid-eye-to-fork length (to the nearest centimeter), and sexed based on external morphological characteristics (coloration, body and fin shape, jaw morphology). Some radiotagged fish may be tagged with a spaghetti tag to assess tag loss, evaluate the effects of spaghetti tagging on post-handling behavior and final spawning destination, and, to provide an external mark for anglers to recognize a fish that has a radio tag.

To minimize any effects from fish holding, only salmon just captured or held for less than 1 hour in the fishwheel live tanks will be radiotagged, and all fish will be released immediately after tagging. All fish captured will be inspected for radio and spaghetti tags.

7.7.4.1.3 Spaghetti Tagging

The fishwheels are expected to capture more fish of most species than needed for radiotagging alone and additional marking of fish will provide information to test assumptions about the representativeness of the fish captured to represent fish passing fishwheel sites, by species, and assess abundance through mark-recapture methods. A portion of these additional fish captured will be spaghetti-tagged, and this portion will vary among species according to their abundance and availability above tagging goals.

All Chinook and coho salmon above the daily goals will be spaghetti-tagged. Tagged Chinook salmon can be subsequently examined in several upstream tributaries to test study assumptions and determine the fraction marked in the different stock (see Objective 8).

Sockeye and chum salmon that spawn above Curry will be available for counting and examining for marks in clear-water side channels and sloughs and tributaries. Given the number of radio tags deployed (200/species), some additional marking of sockeye and chum with spaghetti tags may enable a test for the assumption that capture and marking of fish will be in proportion to stock-specific abundance passing Curry. We expect that insufficient numbers of pink salmon could be tagged (and later examined) to develop a defensible abundance estimate in 2013 (“off-peak” year) or in 2014 (peak-year).

7.7.4.1.4 Tagging Goals

Recent (2012) and historical (1981-85) fishwheel catches, effectiveness, and salmon run timing will guide tag application rates over the season. In 2012, Chinook salmon were captured at RM 30 from the last week of May through the first week of July.

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

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

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

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

7.7.4.2 Objective 2: Determine the migration behavior and spawning locations of radiotagged fish in the lower, middle, and upper Susitna River.

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

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

Two groups of radiotagged fish will be tracked: adult Chinook, coho, chum, pink, and sockeye salmon will be radiotagged and released in the middle river at Curry (RM 120) and Chinook and coho salmon will be tagged in the lower Susitna (RM 30) and Yentna Rivers; Figure 7.7-1). The two study components and data analyses will be tightly coordinated. All mobile (aerial, boat, and foot) and fixed-station receiver data will be analyzed together, and analysis products will be characterized in a consistent manner.

The primary function of the telemetry component is to track these tagged fish spatially and temporally with a combination of fixed and mobile receivers. Time/date stamped, coded radio signals from tags implanted in fish will be recorded by fixed station or mobile positioning. All telemetry gear (tags and receivers) across both studies will be provided by ATS, Inc. (Advanced Telemetry Systems, www.atstrack.com)

The types of behavior to be characterized include:

- Arrival and departure timing at specific locations/positions;
- Direction of travel;
- Residence time at specific locations/positions;
- Travel time between locations/positions;
- Identification of migratory, holding, and spawning time and locations/positions; and
- Movement patterns in and between habitats in relation to water conditions (e.g., discharge, temperature, turbidity).

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

7.7.4.2.1 Fixed-Station Monitoring

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

Figure 7.7-1 shows the locations of the radiotelemetry fixed stations in the lower, middle, and upper rivers. Proposed locations for radiotelemetry fixed stations in the middle and upper river are also shown in greater spatial resolution in Figure 7.7-2 and are listed below.

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

The lower river stations were chosen to represent all significant tributaries that are known to contain or may contain Chinook salmon (Figure 7.7-1). The middle and upper river sites were chosen based on: 1) the need to provide geographic separation of the middle river area to describe migration and spawning behaviors, and 2) monitoring at the appropriate resolution through the upper river area to quantify passage through Devils Canyon. See below for additional details about the telemetric monitoring in Devils Canyon (Objective 3).

7.7.4.2.2 Telemetry Aerial Surveys

Aerial surveys of the mainstem Susitna from RM 22 to Kosina Creek will be conducted by helicopter to allow relatively accurate positioning of tagged fish, to locate spawning areas, and to make visual counts of fish in clear water areas, all with respect to mainstem habitat types. Aerial surveys will begin in July and end in early October (≈14 weeks). Survey timing may be adjusted depending on the observed fishwheel catches in the lower and middle river. Surveys will be scheduled at 5-day intervals with the intent to ensure a maximum of 7 days between surveys with weather contingencies. In the event that fixed stations indicate that no tagged fish have migrated upstream of Devils Canyon, aerial surveys to at least Kosina Creek will be conducted at least three times to confirm these results. If radiotagged fish are detected moving upstream in the mainstem at the Kosina Creek telemetry station, aerial surveys will be extended to locate those radiotagged fish and visually survey for untagged fish.

Surveys via helicopter can be conducted at lower elevations and at slower speeds than can be achieved using fixed-wing aircraft, and therefore will allow more time for signal acquisition, higher spatial resolution, and fish/habitat observations. Fixed-wing surveys are most appropriate when the study goal is a spatial resolution of tagged fish locations to be within approximately 800 meters (i.e., to the nearest 0.5 river mile), and some fixed wing surveys will be conducted about every 10 days. The goal for helicopter-based surveys is to be within approximately 300 meters (1000 feet), as well as to determine whether the fish is in off-channel or mainstem habitat. Higher precision will be achievable in reaches where conditions are most favorable. Geographic coordinates will be recorded for each detected signal using an integrated communication link between the telemetry receiver and a GPS unit. The position of the fish will be determined as that position of the aircraft at the time of the highest signal power. Range testing of the mobile aerial setup will be conducted in the lower river to confirm detection ranges for typical flying heights, receiver gains, and antenna orientation, as well as to work with the helicopter pilot to refine the methods for achieving highest spatial resolution.

The mainstem aerial surveys will need to cover over 200 river miles (RM 22 to RM 230), and multiples of that total when side channels and braids of the lower river are included. To allocate survey effort efficiently and to the highest priority needs, resolution will be a function of fish behavior. The highest priority and highest resolution needs will be for fish that appear to be holding or spawning. For migrating fish, resolution to the nearest 300 meters (~1,000 feet) of river will generally be sufficient. The proposed frequent surveys will provide a means of focusing a higher-resolution and time-intensive tracking effort on identifying exact locations of spawning and holding fish. To do this, the aerial survey team will have available the most recent observed river locations (to the nearest 1 kilometer [0.62 miles]) of all mainstem fish “at large” (i.e., tagged and not tracked in a tributary). During the survey, the “river km” of all detected fish will be compared to the last seen location from previous surveys to ascertain whether its position has changed by more than 2 kilometers (1.25 miles). When tagged fish are within 2 kilometers of their last seen location, the helicopter will circle at a lower altitude to pinpoint the fish location to mainstem, side channel, or slough habitats.

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

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

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

7.7.4.2.3 Lower River Surveys

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

7.7.4.2.4 Middle River Surveys

Mobile aerial surveys of the middle river will cover mainstem areas from the confluence of the Chulitna River (RM 98) through Devils Canyon (≈ RM 150-154). This reach (52 miles) will require approximately one day to complete, and as much as two days late in the season when all tags are deployed.

7.7.4.2.5 Upper River Surveys

Mobile aerial surveys of the upper river will generally be triggered by detection of fish moving above fixed-stations in the Portage and Devils Canyon stations. During station downloads (~weekly), aerial surveys will cover the mainstem areas from Devils Canyon (≈ RM 150-154) to the confluence of the Kosina Creek (RM 206.8). This reach will include approximately 57 relatively confined river miles. This survey will require approximately one survey day; less when done in conjunction with middle river surveys (i.e., when less conveyance time involved). Radiotagged fish above Devils Canyon will be located at a spatial resolution in habitat types similar to the middle and lower river surveys.

7.7.4.2.6 Boat and Ground Surveys

Telemetry surveys will also be conducted by boat and on foot to obtain the most accurate and highest resolution positions of spawning fish. Using the guidance of fixed-station and aerial survey data on the known positions of tagged fish, specific locations of any concentrations of tagged fish that are suspected to be spawning will be visited to obtain individual fish positions. We expect resolution to be within 5-10 meters (16-32 feet) in turbid water and within 2-3 meters (6.5-10 feet) in clear water (dependent on density and highest resolution at low densities). Underwater stripped-coax antennas and judicious use of signal gain control will allow locating tagged fish and recording their geographic position with a GPS. These data will be collected in concert with the field activities and provided to the habitat suitability sampling team to inform their sampling efforts. These surveys will be conducted approximately weekly during the July through September mobile tracking period.

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

The tasks to achieve Objective 3 include the following:

- Establish an array of fixed-station receivers at and above Devils Canyon to monitor the behavior of radiotagged fish from early June to October each year (Figures 7.7-1 and 7.7-2);
- Conduct aerial surveys of the upper river to locate tagged and other salmon; and
- Locate spawning and holding salmon upstream of Devils Canyon.

A combination of fixed-station receivers below (at the Portage Creek confluence, RM 148.8), within (RM 150 and RM 155), and above Devils Canyon will be used to determine the migration timing and behavior of any radiotagged salmon that pass into the upper river area (Figure 7.7-2). Fixed station receivers will be deployed at locations where they will have the highest probability of detecting radiotagged salmon. The fixed station deployed at the confluence with Kosina Creek will provide additional information that can be used to assess the detection efficiencies for all mainstem fixed-station receivers downstream from this site. The data from these receivers will also be used to identify the broad reaches where radiotagged fish are located to guide the aerial and ground-based survey efforts needed to identify spawning areas.

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

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

This objective involves using side-scan and/or DIDSON to determine salmon spawning locations in turbid water.

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

An AEA-sponsored study in August and September 2012 will examine the feasibility of using sonar to find and characterize spawning activity in turbid water. If successful in 2012, the method will be used again in 2013 and 2014 to sample turbid water to quantify spawning activity. Sonar has the potential to detect redds in turbid water and confirm spawning activity by directly monitoring fish behavior. Radio telemetry provides a powerful tool to identify suspected spawning activity but subsequent sampling of fish with sonar may be needed to help determine whether spawning has actually occurred. Net sampling may help to determine the degree of sexual maturation and reduce confusion between holding and spawning areas in some instances. Depending on the results of the feasibility study, a combination of DIDSON and high resolution side-scan sonar may be used in turbid-water spawning areas to search for and map any spawning activity. Emphasis will be placed on any turbid water spawning areas identified in the 2012 radio telemetry study.

7.7.4.4.1 Sonar Equipment and Methods

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

DIDSON is a high-resolution imaging sonar that provides video-type images over a 29-degree field of view and can thus be used to observe fish behavior associated with spawning, i.e., dynamic behavior that cannot be identified on the static side-scan images. To obtain high-quality images of adult salmon the maximum range will be limited to 15 meters (49 feet). Within this field of view, evidence of spawning behavior, e.g., redd digging, chasing, spawning, will be clearly identifiable. Furthermore, on DIDSON images fish can be classified by size category, e.g., < 40 centimeters, 40 – 70 centimeters, > 70 centimeters (< 25 inches, 25-44 inches, > 44 inches, respectively). Although this is not sufficient for definitive species identification, it will allow recognition of smaller resident fish, medium-sized adult salmon, and large Chinook salmon. DIDSON sonar has successfully been used to survey salmon redds in the Columbia River.

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

7.7.4.4.2 Data Analysis and Reporting

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

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

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

Research conducted in the early 1980s provided information relevant to this study. Annual abundance estimates relevant to at least four fishwheel sites along the Susitna River mainstem were developed in each of three years (1983-85). These abundance estimates were apportioned to mainstem, sloughs, and tributaries, and the results will be useful for assessing the potential impacts of the Project. One weakness of these studies was that they relied heavily on visual observations of fish (and abandoned late-season redds). These methods and results may underestimate the use and relative importance of mainstem habitats, many of which occur in turbid water during a substantial portion of the spawning period. Another concern is that data collected approximately 30 years ago may not characterize the current habitat use in the mainstem Susitna River.

This study will address both of these concerns by deploying a similarly scaled study of the spawning runs to the Susitna in 2012-14 and by using radio telemetry and sonar technology not available in the 1980s. Both methods will provide a more rigorous characterization of the use of mainstem habitats than methods used in the 1980s. To the extent spawning distribution and habitat use in the current study are similar to earlier studies, it will greatly increase the sample size and confidence in the conclusions from studies in both periods. Therefore, it will be important to explicitly compare and contrast the distribution and habitat use of salmon in the lower, middle, and upper river habitats of the Susitna River.

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

This objective will be addressed by conducting adult salmon spawning surveys in 2013 and 2014. Aerial surveys by helicopter are being conducted in July and August 2012, and the protocols developed in 2012 will be followed in 2013 and 2014. Multiple surveys will be flown bracketing the peak timing of spawning. Survey aircraft will be equipped with telemetry receivers and GPS to identify positions of tagged and not-tagged Chinook salmon and any other Pacific salmon that may be observed.

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

The task for this objective is to collect genetic samples opportunistically from adult anadromous salmon in conjunction with addressing Objectives 1 and 2. Sample collections will be coordinated with the Genetic Baseline Study team (see Section 7.14). Similar to commitments made for 2012, this study will identify the locations of spawning fish and where it is feasible, collect tissue for use with genetics studies by ADF&G and other researchers.

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

A commonly applied two-event, capture-recapture experiment will be used to estimate the abundance of Chinook salmon in the entire Susitna River drainage. Fishwheels will be used to capture fish for marking. Weirs on tributaries of the Susitna River will be used to recapture marked fish. The best sites for fishwheel operation will likely be on the Yentna River and a second site on the mainstem Susitna River near RM 26, with two fishwheels at each site. At the weir recapture sites Chinook salmon will be counted and inspected for tags. Likely weir recapture sites (in addition to the existing Deshka River weir operated by ADF&G) include Willow Creek and the Middle Chulitna River on the east side of the Susitna River, as well as Talachulitna River and Lake Creek on the west side of the Susitna. It may also be possible to use genetics to identify the spawning destination of fish captured at the fishwheels. Studies being conducted in the summer of 2012 will determine the feasibility of using genetics to serve as an identifiable mark and eliminate the need to address tag loss and tagging effects associated with traditional capture-recapture models.

Radio telemetry would be used to identify the primary spawning locations. A subsample of Chinook salmon captured in the fishwheels will be radiotagged throughout the runs. Radiotagged salmon will be relocated using fixed tracking stations and repeated aerial surveys over the major tributaries. Tissue samples will be collected from the radiotagged fish to add to the Cook Inlet Chinook salmon genetic baseline.

A two-event, capture-recapture experiment will also be used to estimate the abundance of coho salmon in the Susitna River upstream of the confluence with the Yentna River. Fishwheels will be used to capture fish for marking with tags. Weirs on the tributaries (likely the Deshka River, Middle Chulitna River and Willow Creek) and/or possibly fishwheels near Sunshine will be used to recapture marked fish. At the weir recapture sites, coho salmon will be counted and inspected for a tag.

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

7.7.5. Consistency with Generally Accepted Scientific Practice

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

7.7.6. Schedule

This is a multi-year study, most components of which were initiated in 2012. The schedule for 2013-2014 activities is as follows:

- Operate fishwheels in the lower Susitna and Yentna rivers from May through August, 2013 and 2014.
- Operate fishwheels at Curry from June through early September, 2013 and 2014.
- Conduct aerial surveys from mid-June through September in the lower river and from mid-July through early October in middle and upper river.
- Quality Controlled (QC) Data - December, 2013 and 2014.
- QC'd geospatially-referenced relational database – December, 2013 and 2014.
- Initial Study Report – December 2013
- Updated Study Report - December 2014.

7.7.7. Level of Effort and Cost

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

Estimated costs for lower river tagging of Chinook and system-wide abundance estimate (includes the shared cost of weirs, boats, vehicles, and a DIDSON sonar to be used for enumerating coho salmon):

- 2013: $1,100,000 – $1,300,000
- 2014: $790,000 – $850,000

Estimated costs for lower river tagging of coho salmon objectives (assumes boats, weirs, DIDSON and vehicles covered under Chinook estimate):

- 2013: $300,000 – $400,000
- 2014: $300,000 – $400,000

7.7.8. Literature Cited

AEA (Alaska Energy Authority). 2011a. Aquatic Resources Gap Analysis. Prepared by HDR, Inc., Anchorage. 107 pp.

AEA. 2011b. Pre-application Document: Susitna-Watana Hydroelectric Project FERC Project No. 14241. December 2011. Prepared for the Federal Energy Regulatory Commission, Washington, DC.

Alaska Department of Fish and Game. Fair, L.F., T.M. Willette, J.W. Erickson, R.J. Yanusz, and T.R. McKinley. 2010. Review of salmon escapement goals in Upper Cook Inlet, Alaska 2011. Alaska Department of Fish and Game, Fishery Manuscript Series No. 10–06, Anchorage.

Buckwalter, J. D. 2011. Synopsis of ADF&G's Upper Susitna Drainage fish inventory, August 2011. Alaska Department of Fish and Game.

Cannon, R. 1986. Susitna River aquatic studies review: findings and recommendations of the Susitna program review team.

Fall, J. A. and D. J. Foster. 1987. Fish and game harvest and use in the Middle Susitna Basin: the results of a survey of residents of the road-connected areas of Game Management Units 14B and 16A, 1986. Technical Paper No. 143. Alaska Department of Fish and Game, Division of Subsistence, Juneau, Alaska.

Ivey, S., C. Brockman, and D. Rutz. 2009. Area management report for the recreational fisheries of Northern Cook Inlet, 2005 and 2006. Alaska Department of Fish and Game, Fishery Management Report No. 09-27, Anchorage.

Ivey, S., C. Brockman, and D. Rutz. 2009. Area management report for the recreational fisheries of Northern Cook Inlet, 2005 and 2006. Alaska Department of Fish and Game, Fishery Management Report No. 09-27, Anchorage.

Merizon, R. A., R. J. Yanusz, D. J. Reed, and T. R. Spencer. 2010. Distribution of spawning Susitna River chum Oncorhynchus keta and coho O. kisutch salmon, 2009. Alaska Department of Fish and Game Fishery Data Series No. 10-72, Anchorage.

Oslund, S. and S. Ivey. 2010. Recreational Fisheries of Northern Cook Inlet, 2009–2010: A Report to the Alaska Board of Fisheries, February 2011. Alaska Department of Fish and Game, Fishery Management Report No. 10-50, Anchorage.

Shields, P. 2010. UpperCook Inlet commercial fisheries annual management report, 2010. Alaska Department of Fish and Game, Fishery Management Report No. 10-54, Anchorage.

Thompson, F. M., S. N. Wick, and B. L. Stratton. 1986. Adult salmon investigations May – October 1985. Alaska Department of Fish and Game, Susitna Hydro Aquatic Studies Report Series 13, Anchorage.

Woodward-Clyde Consultants, and Entrix, Inc. 1985. Fish Resources and Habitats in the Middle Susitna River. Technical Report No. 1. Instream Flow Relationships Series. Alaska Power Authority Susitna Hydroelectric Project. Vol. 1.

Yanusz, R., R. Merizon, D. Evans, M. Willette, T. Spencer, and S. Raborn. 2007. Inriver abundance and distribution of spawning Susitna River Sockeye salmon Oncorhynchus nerka, 2006.

Yanusz, R. J., R. A. Merizon, T. M. Willette, D. G. Evans, and T. R. Spencer. 2011. Inriver Abundance and Distribution of Spawning Susitna River Sockeye Salmon Oncorhynchus nerka, 2008. Alaska Fishery Data Series No. 11-12. Department of Fish and Game, Divisions of Sport and Fish and Commercial Fisheries.

7.7.9. Figures

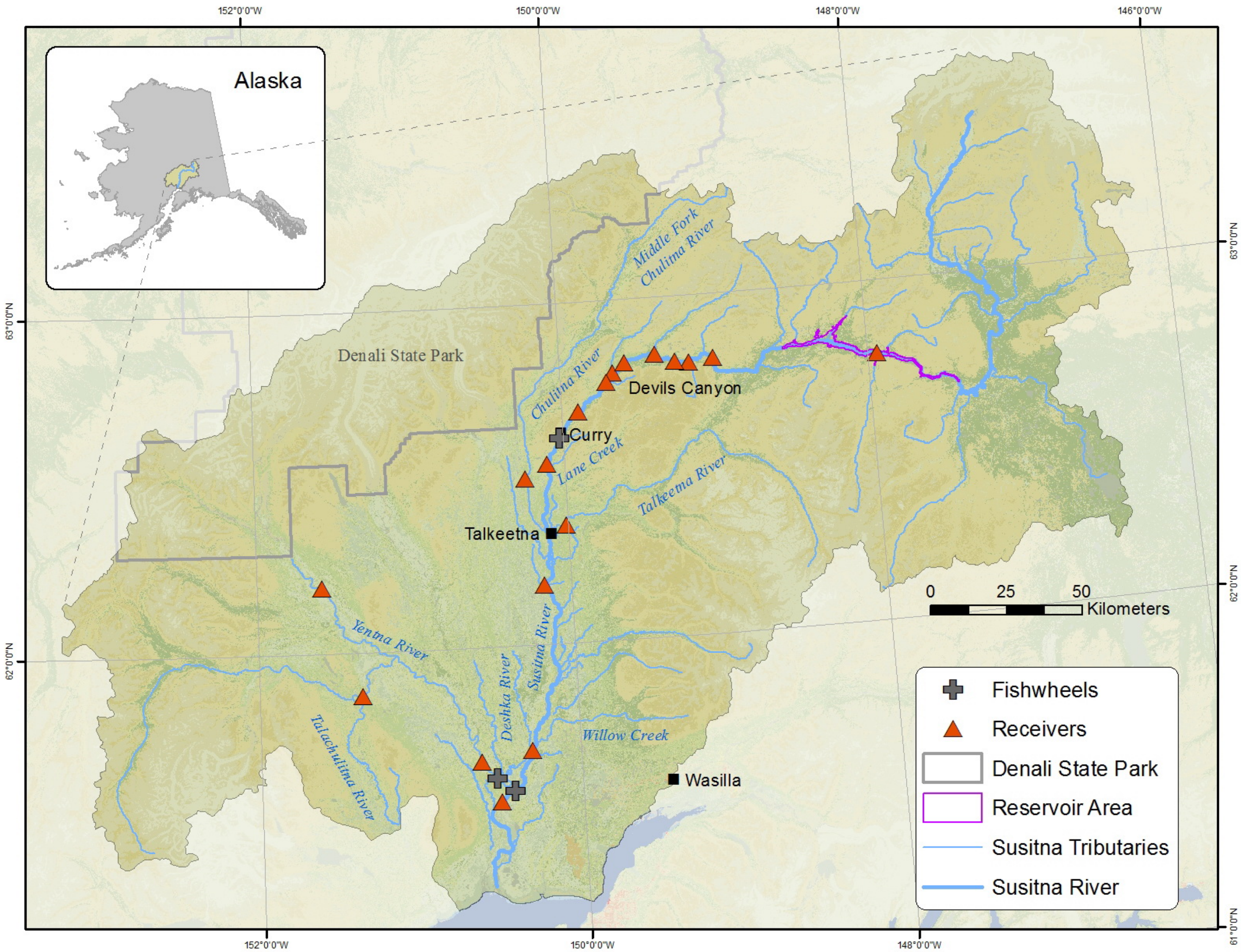


Figure 7.7-1. Susitna watershed showing fish capture sites (fishwheels) and the locations of fixed-station telemetry receivers in the Susitna River.

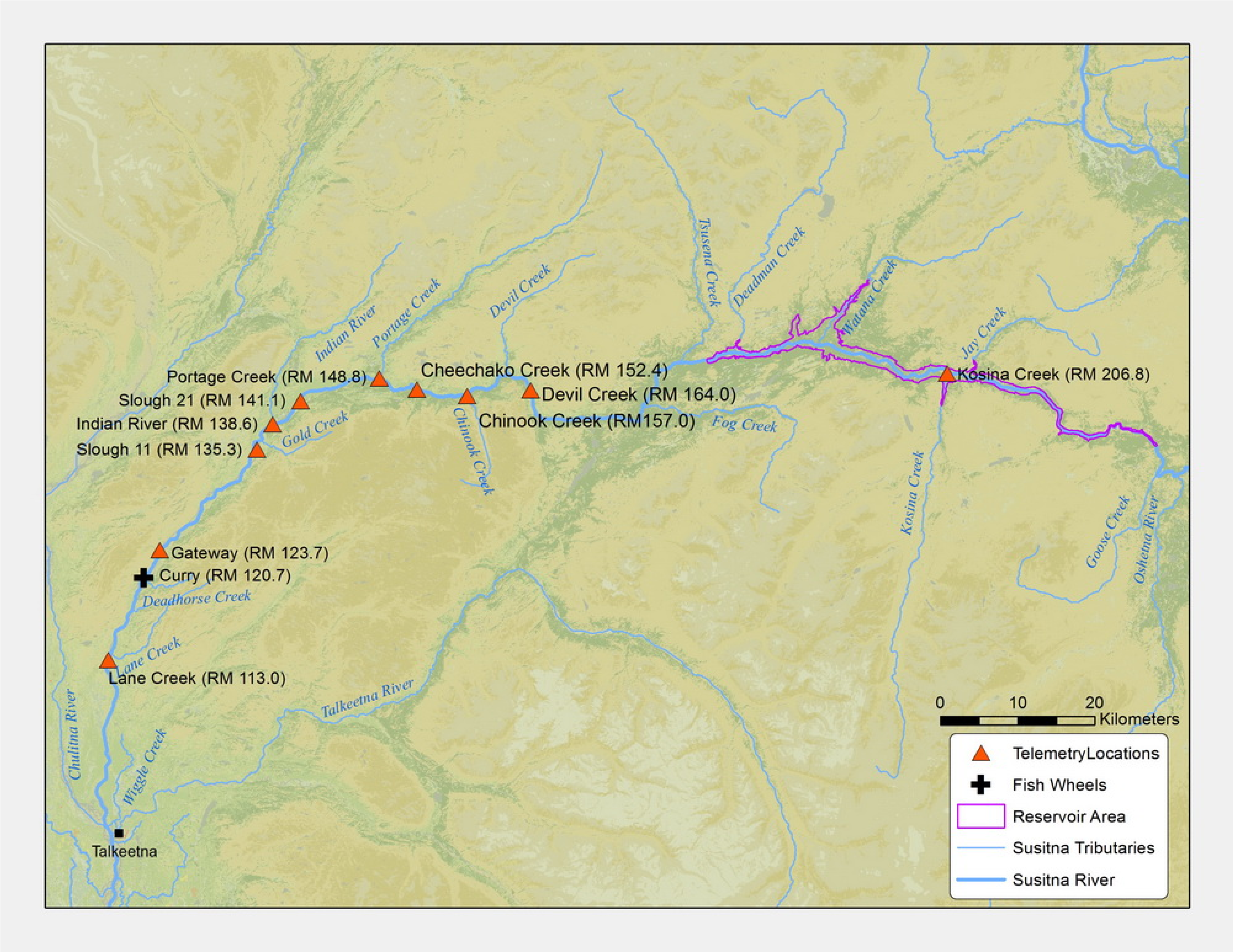


Figure 7.7-2. Fixed-station telemetry receivers in the middle and upper Susitna River, 2012-14.

7.8. River Productivity Study

7.8.1. General Description of the Proposed Study

Algae are an important base component in the lotic food web, being responsible for the majority of photosynthesis in a river or stream and serving as an important food source to many benthic macroinvertebrates. In turn, benthic macroinvertebrates are an essential component in the processes of an aquatic ecosystem, due to their position as consumers at the intermediate trophic level of lotic food webs (Hynes 1970; Wallace and Webster 1996; Hershey and Lamberti 2001). Macroinvertebrates are involved in the recycling of nutrients and the decomposition of organic materials, serving as a conduit for the energy flow from organic matter resources to vertebrate populations, such as fish (Hershey and Lamberti 2001; Hauer and Resh 1996; Reice and Wohlenberg 1993; Klemm et al. 1990).

The significant functional roles that macroinvertebrates and algae play in the freshwater ecosystem make these communities important elements in the study of a stream's ecology. The operations of the proposed Project would likely affect one or more of the factors that can affect the abundance and distribution of benthic macroinvertebrate and benthic algae populations. The degree of impact on the benthic communities and fish resulting from hydropower operations will necessarily vary depending on the magnitude, frequency, duration, and timing of flows, as well as potential Project-related changes in geomorphology, ice processes, temperature and turbidity. By investigating the current populations in the Susitna River, this study will generate information about the current health and status of these populations throughout the varied habitats in the Susitna River. In addition, by applying what is known about the relationships between river regulation and hydropower operation, we can begin to assess the potential impacts of Project operations, as well as provide information to inform development of any necessary protection, mitigation, and enhancement (PM&E) measures.

7.8.1.1. Study Goals and Objectives

The overarching goal of this study is to evaluate the effects of Project-induced changes in flow and the interrelated environmental factors (temperature, substrate, water quality) upon the benthic macroinvertebrate and algal communities in the middle and upper Susitna River. Individual objectives that will accomplish this are listed below.

1. Synthesize existing literature on the impacts of hydropower development and operations (including temperature and turbidity) on benthic macroinvertebrate and algal communities;
2. Characterize the pre-Project benthic macroinvertebrate and algal communities with regard to species composition and abundance in the middle and upper Susitna River;
3. Estimate drift of benthic macroinvertebrates in selected habitats within the middle and upper Susitna River to assess food availability to juvenile and resident fishes;
4. Conduct a literature/data search to identify existing river systems that could act as surrogates in evaluating future changes to productivity in the Susitna River.

5. Conduct a review on the feasibility of a trophic analysis to describe potential changes in the primary and secondary productivity of the riverine community following Project construction and operation;
6. Generate habitat suitability criteria for Susitna benthic macroinvertebrate and algal habitats to predict potential change in these habitats downstream of proposed dam site;
7. Characterize the macroinvertebrate compositions in the diets of representative fish species in relationship to their source (benthic or drift component);
8. Characterize organic matter resources (e.g., available for macroinvertebrate consumers) including course particulate organic matter, fine particulate organic matter, and suspended organic matter in the lower, middle, and upper Susitna River.
9. Estimate benthic macroinvertebrate colonization rates in the middle and lower reaches to monitor baseline conditions and evaluate future changes to productivity in the Susitna River.

7.8.2. Existing Information and Need for Additional Information

A number of evaluations of the benthic macroinvertebrate community were conducted on the Susitna River in the 1970s and in the 1980s for the original APA Susitna Hydroelectric Project (Friese 1975; Riis 1975, 1977; ADF&G 1983; Hansen and Richards 1985; Trihey and Associates 1986). ADF&G studies in the 1970s included sampling of macroinvertebrates using artificial substrates (rock baskets) deployed for a set period of time to allow for colonization. Friese (1975) and Riis (1975) set a total of eight rock baskets in Waterfall Creek, Indian River, and the mainstem middle Susitna River for 30 days during summer (July – September). Riis (1977) also deployed rock baskets in the Susitna River near the mouth of Gold Creek for a colonization period of 75 days; however, only two of seven baskets were retrieved. Results were limited to low numbers of invertebrates per basket, identified to taxonomic family.

Studies conducted in the 1980s for the original APA Susitna Hydroelectric Project focused on benthic macroinvertebrate communities in the sloughs, side channels, and tributaries of the middle reach of the Susitna River from RM 125 to RM 142 during the period from May through October. Efforts included direct benthic sampling with a Hess bottom sampler and drift sampling. ADF&G efforts in 1982 and 1984 also involved collection of juvenile salmon in these side channels and sloughs, and an analysis was conducted to compare gut contents with the drift and benthic sampling results (ADF&G 1983; Hansen and Richards 1985). In addition, Hansen and Richards (1985) collected water velocity, depth, and substrate-type data to develop habitat suitability criteria (HSC), which were used to estimate weighted usable areas for different invertebrate community guilds, based on their behavioral type (swimmers, burrowers, clingers) in slough and side channel habitats. Efforts in 1985 (Trihey and Associates 1986) expanded to include sampling at nine sites in the Middle Susitna River Reach: 3 side channels, 2 sloughs, 2 tributaries, and 2 mainstem sites.

Algal communities were sampled and analyzed for chlorophyll-*a* periodically at Susitna Station from 1978 to 1980. In the 1980s, algae samples were collected as part of the APA Susitna Hydroelectric Project water quality studies, with sampling conducted at Denali, Cantwell (Vee Canyon), Gold Creek, Sunshine, and Susitna Station on the Susitna River, as well as on the Chulitna and Talkeetna rivers (Harza-Ebasco 1985 as cited in AEA 2011). Analysis showed low productivity (less than 1.25 mg/m^3 chlorophyll-*a*) and indicated algal abundance was most likely limited by high concentrations of turbidity (AEA 2011).

Benthic macroinvertebrate information from the 1980s is focused on a limited number of side channel and slough habitats within a 17-mile reach of the Middle Susitna River. Additional information is needed on mainstem benthic communities, as well as those in side channel and slough habitats, within both the Middle and Upper Susitna River reaches. Benthic algae information needs to be collected in conjunction with the macroinvertebrates to define their relationship in the river's trophic system. To assess the impact of future hydropower operations on the benthic communities within the Susitna River, additional information must be collected through an increased sampling effort, including more sampling sites along the river in relation to the distance both downstream from the proposed dam site and upstream from the dam. Additionally samples collected seasonally in the reservoir pool, are needed to help define variability in these communities throughout the year.

7.8.3. Study Area

The River Productivity study will entail field sampling throughout all three of the designated study reaches on the Susitna River (Table 7.8-1; Figures 7.8-1 through 7.8-3). The Upper Susitna River Reach is defined as the section of river above the proposed Watana Dam site at RM 184 (Figure 7.8-1). Sampling within the lower 39 miles of this reach (RM 184 – 233) will document the benthic communities that will eventually be inundated by the proposed reservoir. Sampling in the upper portions of this reach will investigate the benthic communities that will be unaffected by inundation. The Middle Susitna River Reach encompasses the 86-mile section of river between the proposed Watana Dam site and the Chulitna River confluence, located at RM 98 (Figure 7.8-2). Sampling activities within this reach will investigate the benthic communities that may be affected by the Project and its regulated flows. Sampling will be conducted at various distances from the proposed dam site to document longitudinal variability, and estimate the effects that the Project will have on benthos in the river system downstream. The Lower Susitna River Reach is defined as the approximate 98-mile section of river between the Chulitna and Talkeetna rivers confluence and Cook Inlet (Figure 7.8-3) (AEA 2011). Sampling will occur in the upper portion of this reach to determine to what extent, if any, the Project operations would affect benthic communities, as well as the ameliorating affect the two tributaries may have on the mainstem Susitna River below the confluence of the three rivers.

7.8.4. Study Methods

To evaluate the effects of Project-induced changes in flow and the interrelated environmental factors (temperature, substrate, water quality) on the benthic macroinvertebrate and algal communities in the Susitna River, the following nine study components have been proposed:

7.8.4.1. Synthesize existing information on the impacts of hydropower development and operations (including temperature and turbidity) on benthic macroinvertebrate and algal communities.

Several reviews have been written on the effects that modified flows have on the benthic communities residing below dams (Ward 1976; Ward and Stanford 1979; Armitage 1984; Petts 1984; Cushman 1985; Saltveit et al. 1987; Brittain and Saltveit 1989). A majority of these reviews indicate that temperature and flow regimes are often the most important factors affecting benthic macroinvertebrates below dams. The type of dam and its mode of operation will have a large influence over the type and magnitude of effects on the receiving stream below. General information on the effects of hydropower on riverine habitats, as well as Project-specific information, will be reviewed and synthesized. Specifically, the literature review will summarize relevant literature on macroinvertebrate and algal community information in Alaska, including 1980s Susitna River data; review and summarize literature on general influences of changes in flow, temperature, substrates, nutrients, turbidity, light penetration, and riparian habitat on benthic communities; and review and summarize the potential effects of dams and hydropower operations, including flushing flows and load following, on benthic communities and their habitats.

7.8.4.2. Characterize the pre-Project benthic macroinvertebrate and algal communities with regard to species composition and abundance in the Susitna River.

7.8.4.2.1. Benthic macroinvertebrate sampling

Macroinvertebrate sampling will be stratified by reach and mainstem habitat type defined in the Project-specific habitat classification scheme (mainstem, tributary confluences, side channels, and sloughs). To accomplish this objective, sampling will occur at 27 sites (9 mainstem and 18 associated off-channel sites) above and below the proposed dam site (RM 184) (Table 7.8-1). Efforts will be made to locate sampling sites at transects established by the instream flow team, in an attempt to correlate macroinvertebrate data with additional environmental data (flow, substrates, temperature, water quality, riparian habitat, etc) for statistical analyses, and HSC development. Three sampling periods will occur from April through October in both study years (2013-2014) to capture seasonal variation in community structure and productivity. In addition, sampling will be conducted in February/March to collect information on winter productivity. However, winter sampling will be limited to a select number of accessible open-water sites.

Sampling will be conducted in riffle habitats within each mainstem habitat type (i.e., mainstem, tributary confluences, side channels, and sloughs). Benthic macroinvertebrate sampling will be conducted using a stream-type sampler (Hess, Surber, Slack) commonly used for other Alaskan benthic macroinvertebrate studies to allow for comparable results; state and federal protocols, as well as methods used in the Susitna River studies in the 1980s, will be considered when designing the sampling approach (Hansen and Richards 1985; Carter and Resh 2001; Klemm et al. 1990; Klemm et al. 2000; Moulton et al. 2002; Peck et al. 2006). Replicate samples (n=6) will be collected to allow for statistical testing of results for short- and long-term monitoring. Measurements of depth, mean water column velocity, and substrate composition will be taken concurrently with benthic macroinvertebrate sampling at the sample location for use in HSC development in the instream flow studies.

In addition, due to the prevalence of large woody debris in the Susitna River, woody snags also will be sampled as a substrate strata for benthic macroinvertebrates as requested by USFWS (USFWS River Productivity Study Request, May 31, 2012). Sampling methods for woody snags will be semi-quantitative (Moulton et al. 2002). Suitable woody snags will have been submerged for an extended period of time so as to be clearly colonized. Sections of woody snags to be sampled will be removed from the water by using a saw, and placed over a plastic bin or in a bucket, and all benthic macroinvertebrates will be removed by handpicking, brushing, and rinsing. The snags will be allowed to dry for a period of time, so that missed organisms will crawl out of the crevices and then can be collected. Snag sections sampled will be measured for length and average diameter to determine surface area sampled. Each snag section will count as a separate, replicate sample.

Benthic macroinvertebrate samples will be processed in a laboratory using methods compatible with those used for other studies in comparable streams/basins in Alaska. State and federal protocols (Barbour et al. 1999; Major and Barbour 2001; Moulton et al. 2002) will be considered when making decisions about the sample processing protocols, including subsampling protocols and the taxonomic resolution of specimen identifications.

Results generated from the collections will include several descriptive metrics commonly used in aquatic ecological studies, such as density (individuals per unit of area), taxa richness (both mean and total), EPT taxa (i.e., *Ephemeroptera, Plecoptera, Trichoptera*) richness, diversity (H'), evenness (J'), percent dominant taxa, the relative abundance of major taxonomic groups, and the relative abundance of the functional feeding groups. Data collected during this study will be compared to the results of 1980s studies (ADF&G 1983; Hansen and Richards 1985; Trihey and Associates 1986) to evaluate any differences between the historic and current community structure. In addition, any invasive benthic macroinvertebrates identified in the sample collections will be identified and their collection locations will be recorded using GIS (NAD 83).

7.8.4.2.2. Benthic algae sampling

Benthic algae sampling will be collected concurrently with benthic macroinvertebrate sampling to allow for correlation between the two collections (Table 7.8-1). Benthic algae sampling will be conducted using methods compatible with other Alaska benthic algal studies, to allow for comparison of results. State and federal protocols will be considered when designing the sampling approach (Eaton et al. 1998; Barbour et al. 1999; Moulton et al. 2002; Peck et al. 2006). Measurements of depth, mean water column velocity, turbidity, and substrate composition will be taken concurrently with algae sampling at the sample location for use in HSC development in the instream flow studies.

Benthic algae samples will be processed in a laboratory, using methods compatible with those used for other studies in comparable streams/basins in Alaska, considering state and federal protocols (Eaton et al. 1998; Barbour et al. 1999; Moulton et al. 2002; Peck et al. 2006) to determine sample processing protocols, including subsampling protocols, and the taxonomic resolution of specimen identifications.

Results generated from the collections would include both dry weight and chlorophyll *a*, and several descriptive metrics to describe the algal community. In addition, any invasive algae taxa identified in the sample collections will be identified and their locations will be recorded using GIS (NAD 83).

7.8.4.3. Estimate drift of invertebrates in selected habitats within the Susitna River to assess food availability to juvenile and resident fishes.

Invertebrate drift sampling will be conducted concurrently with benthic macroinvertebrate sampling at nine of the established benthic collection sites to allow for comparisons between the two collections. Sampling will be stratified by reach and conducted in riffle habitats within the mainstem, tributary confluences, side channels, and sloughs (Table 7.8-1).

Invertebrate drift sampling will be conducted using a drift net similar to those used for other drift studies in Alaska to allow for comparison of results; state and federal protocols will be considered (Keup 1988; Klemm et al. 2000). Drift sampling will be conducted during daytime hours, as a measure of background drift that is available to feeding fish (Waters 1972; Brittain and Eikeland 1988; Keup 1988). Sampling methods will involve collecting duplicate samples to allow for statistical testing of results for short- and long-term monitoring. Water velocity directly in front of the net will be recorded both upon deployment and upon retrieval of the net. Invertebrate drift samples will be processed in a laboratory, using methods compatible with other studies conducted in comparable streams/basins in Alaska. State and federal protocols (Barbour et al. 1999; Major and Barbour 2001; Moulton et al. 2002) will be considered when making decisions about the sample processing protocols, including subsampling protocols, taxonomic resolution of specimen identifications, and length measurements for individual specimens.

Results generated from these collections will include drift density, drift rate, and drift composition. Data collected as part of this study will be compared to data from the benthic macroinvertebrate collections (Section 7.8.4.2.1) and the fish dietary analysis (Section 7.8.4.7). In addition, drift results will be compared to the results of 1980s drift studies (ADF&G 1983; Hansen and Richards 1985; Trihey and Associates 1986) to evaluate any differences between the historic and current drift components of the macroinvertebrate communities.

7.8.4.4. Conduct a literature/data search to identify existing river systems that could act as surrogates in evaluating future changes to productivity in the Susitna River.

The literature search will focus on comparable river systems in Alaska and elsewhere. Information will be collected for turbid and non-turbid systems, especially those in glacial systems with lakes. By comparing the response of benthic communities in these systems to environmental perturbations that are similar to those anticipated in the Susitna River (such as changes in turbidity and light penetration), we hope to increase our ability to predict how the benthic communities in the Susitna River may respond to Project-induced changes. If, during this review, one or more comparable Alaska river systems are identified, this task will also evaluate the feasibility of collecting field data from those rivers.

7.8.4.5. Conduct a review on the feasibility of a trophic analysis to describe potential changes in the primary and secondary productivity of the riverine community following project construction and operation.

As a Phase I study, a literature review will be conducted to examine and summarize the various existing approaches for conducting trophic analyses, including methods and the level of effort required to obtain sufficient data to conduct a site-specific trophic analysis for the Susitna River. In addition, an investigation will be conducted on the ability of the river water quality model (Water Quality Modeling Study, see Section 5.6) to predict changes in primary productivity in the Susitna River as the result of changes in turbidity and temperature. Based upon the results of the review and investigation, recommendations will be made on whether to conduct a trophic analysis as a Phase II to this study.

7.8.4.6. Generate habitat suitability criteria for Susitna benthic macroinvertebrate and algal habitats to predict potential change in these habitats downstream of proposed dam site.

A literature review will be conducted, examining the existing 1980s study (Hansen and Richards 1985) for applicable information and methodology, as well as peer-reviewed periodicals, and government and industry technical reports for applicable benthic macroinvertebrate and algae HSC and their use for instream flow analysis. The review will also examine macroinvertebrate life histories, behavior, and functional feeding groups to assist in grouping taxa into guilds. Velocity, depth, and substrate data collected during benthic macroinvertebrate and benthic algae sampling (as stated in Objective 2, Section 7.8.4.2) will be used to generate HSC criteria for Susitna River benthic populations. These criteria will be used to simulate how the suitable macroinvertebrate and algal benthic habitat may change in response to Project-induced changes to flow, water depth and velocity. Data collection and transect information will be coordinated with the Instream Flow Study. Analysis and modeling efforts will be coordinated with the Instream Flow Team.

7.8.4.7. Characterize the macroinvertebrate compositions in the diets of representative fish species in relationship to their source (benthic or drift component).

Because macroinvertebrates are a food source for fish and other organisms (Hershey and Lamberti 2001), any significant disturbance to the benthic community has the possibility of affecting their predators. Therefore, it is important to investigate the trophic relationship between fish and the macroinvertebrate community, by conducting a fish gut analysis and comparing results to drift and benthic invertebrate data. Target fish species will be identified in consultation with those conducting fish distribution and abundance studies (Fish Distribution and Abundance in the Middle and Lower Susitna River Study, Fish Distribution and Abundance in the Upper Susitna River Study, and/or Salmon Escapement Study teams) and other licensing participants. Fish collection sites will correspond to benthic macroinvertebrate collection sites (both bottom and drift sampling) to allow for comparison with the macroinvertebrate community composition. Fish stomach contents will be sampled using non-lethal methods (Hyslop 1980; Bowen 1996; Kamler and Pope 2001). The collection efforts will be coordinated with the appropriate fish study team.

Fish gut content samples will be processed in a laboratory using methods compatible with studies conducted in other comparable streams/basins in Alaska. State and federal protocols (Hyslop 1980; Bowen 1996; Barbour et al. 1999; Major and Barbour 2001; Moulton et al. 2000) will be considered in determining the sample processing protocols, including subsampling protocols, the taxonomic resolution of specimen identifications, and data analysis approach. Data collected during this study will be compared to the results of 1980s fish diet studies (ADF&G 1983; Hansen and Richards 1985) to evaluate any differences between the historic and current fish diets.

7.8.4.8. Characterize organic matter resources (e.g., available for macroinvertebrate consumers) including course particulate organic matter, fine particulate organic matter, and suspended organic matter in the lower, middle, and upper Susitna River.

Organic matter materials serve as an important food resource to benthic macroinvertebrates, serving as a conduit for the energy flow from organic matter resources to vertebrate populations, such as fish (Hershey and Lamberti 2001; Hauer and Resh 1996; Reice and Wohlenberg 1993; Klemm et al. 1990). This organic matter exists as both fine particulate organic matter (FPOM) and course particulate organic matter (CPOM). FPOM includes particles ranging from 0.45 to 1000 µm in size, and can occur in the water column as seston, or deposited in lotic habitats as fine benthic organic matter (FBOM) (Wallace and Grubaugh 1996). CPOM is defined as any organic particle larger than 1 mm in size (Cummins 1974).

In order to quantify the amounts of organic matter available in the Susitna River for river productivity, CPOM and FPOM (specifically FBOM) will be collected concurrently with all benthic macroinvertebrate sampling (Objective 2, Section 7.8.4.2.1). Suspended FPOM (Seston) will be collected at same time and alongside invertebrate drift sampling (Objective 3, Section 7.8.4.3). Organic matter collection will be conducted using methods compatible with other Alaska studies, to allow for comparable results. State and federal protocols will be considered as study plans are developed, in consultation with resource agencies.

7.8.4.9. Estimate benthic macroinvertebrate colonization rates in the middle and lower reaches to monitor baseline conditions and evaluate future changes to productivity in the Susitna River.

Colonization is a process in which organisms move into and become established in new areas or habitats (Smock 1996). In disturbed habitats, this process is more accurately called recolonization. Numerous studies have shown that macroinvertebrates can rapidly colonize new or disturbed substrates (Shaw and Minshall 1980; Ciborowski and Clifford 1984; Williams and Hynes 1977; Townsend and Hildrew 1976; Miyake et al. 2003). The rate of recolonization is dependent on several factors, including time of the year, substratum particle size, the structure of the macroinvertebrate assemblages available to colonize at the time, and the distance of the colonist assemblages from the new or disturbed area (Robinson et al. 1990; Smock 1996; Mackay 1992).

Using a stratified sampling approach, a field study will be conducted to estimate potential benthic macroinvertebrate colonization rates for different seasons in the Susitna River. Sets of three to five preconditioned artificial substrates will be deployed incrementally for set periods of colonization time (e.g., 12, 8, 6, 4, 2, and 1 weeks) and then pulled simultaneously at the conclusion of the colonization period. Artificial substrates will be deployed at three depths at fixed sites along the channel bed. Benthic macroinvertebrate colonization rates may be conducted in a variety of habitats (e.g., turbid vs. non-turbid areas, groundwater upwelling areas vs. areas without groundwater upwelling). Benthic macroinvertebrate processing protocols would be identical to those used in sampling in the middle Susitna River (Objective 2, Section 7.8.4.2.1). State and federal protocols for both sampling and processing will be considered as the details of this study component are refined, in consultation with resource agencies.

Colonization information will be compared with colonization results from similar river systems and with post-project colonization results.

7.8.5. Consistency with Generally Accepted Scientific Practices

The methods described herein have been developed in consultation with Agency and Technical workgroup participants. All data collection efforts will follow state or federal guidelines referenced throughout the study methods discussion. In addition, any laboratory analysis will be conducted by a state- or federally-certified facility.

7.8.6. Schedule

The preliminary schedule for the river productivity study elements is presented in Table 7.8-2. During the third and fourth quarters of 2012, the literature review summarizing the impacts of hydropower development and operations on benthic macroinvertebrate and algal communities will be prepared and presented to the TWG. Research, field sampling, and sample processing and analysis will begin in the latter half of the first quarter of 2013, following FERC's approval of the study plan, and continue throughout the remainder of 2013. The Initial Study Report summarizing 2012 and 2013 activities will be issued in December 2013. Field sampling efforts will resume in the latter half of the first quarter of 2014, with analysis and research continuing through the fourth quarter. The Updated Study Report will be produced in December 2014.

7.8.7. Level of Effort and Cost

The initial cost estimate for completion of the nine study objectives above is $800,000. Efforts such as the literature review, trophic analysis, and HSC criteria development will be office-based studies. Collection of benthic macroinvertebrates and algae, with the addition of an analysis of fish feeding habits, will require at least four field efforts per year for the two study years. The colonization study will require frequent site visits each month to deploy additional sets of samplers over the course of the study. A majority of the work effort will take place in the laboratory to subsample, sort, and identify the macroinvertebrate and algae samples. The remainder of the study effort, after sample processing, will be office-based, consisting of data entry, analysis, and synthesis and report writing.

7.8.8. Literature Cited

Alaska Department of Fish and Game (ADF&G). 1983. Volume 3. Resident and juvenile anadromous fish studies on the Susitna River below Devil Canyon, 1982. Susitna Hydro Aquatic Studies, Phase II Basic Data Report. Prepared for Alaska Power Authority. Alaska Department of Fish and Game, Anchorage, Alaska. APA Document 486.

AEA. 2011. Pre-application Document: Susitna-Watana Hydroelectric Project FERC Project No. 14241. December 2011. Prepared for the Federal Energy Regulatory Commission, Washington, DC.

Armitage, P.D. 1984. Environmental changes induced by stream regulation and their effect on lotic macroinvertebrate communities. Pages 139-164 *in* A. Lillehammer and S.J. Saltveit, editors. Regulated Rivers. Universitetsforlaget AS, Norway.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: Periphyton, benthic macroinvertebrates and fish. Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington D.C.

Bowen, S.H. 1996. Quantitative description of the diet. Pages 513-529 *in* B. R. Murphy and D. W. Willis, eds., Fisheries Techniques (Second Edition). American Fisheries Society, Bethesda, Maryland, USA.

Brittain, J.E. and T.J. Eikeland. 1988. Invertebrate drift – A review. Hydrobiologia 166: 77-93.

Brittain, J.E. and S.J. Saltveit. 1989. A review of the effect of river regulation on mayflies (Ephemeroptera). Regulated Rivers: Research and Management 3: 191-204.

Carter, J.L. and V.H. Resh. 2001. After site selection and before data analysis: sampling, sorting, and laboratory procedures used in stream benthic macroinvertebrate monitoring programs by USA state agencies. Journal of the North American Benthological Society 20(4): 658-682.

Ciborowski, J.J.H. and H.F. Clifford. 1984. Short-term colonization patterns of lotic macroinvertebrates. Canadian Journal of Fisheries and Aquatic Sciences 41: 1626-1633.

Cummins, K.W. 1974. Structure and function of stream ecosystems. Bioscience 24: 631-641.

Cushman, R.M. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American Journal of Fisheries Management 5: 330-339.

Eaton, A., L. Clesceri, A. Greenberg. 1998. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, American Water Works Association, Water Environment Federation, Washington, D.C.

Friese, N.Y. 1975. Pre-authorization assessment of anadromous fish populations of the Upper Susitna River watershed in the vicinity of the proposed Devil Canyon Hydroelectric Project. Prepared for the U.S. Fish and Wildlife Service, Anchorage, Alaska. Alaska Department of Fish and Game. APA Document 1611

Hansen, T.F. and J.C. Richards. 1985. Availability of invertebrate food sources for rearing juvenile Chinook salmon in turbid Susitna River habitats. Susitna Hydro Aquatic Studies, Report No. 8. Prepared for Alaska Power Authority. Alaska Department of Fish and Game, Anchorage, Alaska. APA Document No. 2846.

Hauer, F.R. and V.H. Resh. 1996. Benthic macroinvertebrates. Pages 339-369 *in* F.H. Hauer and G.A. Lamberti, editors. Methods in stream ecology. Academic Press, San Diego, California.

Hershey, A.E. and G.A. Lamberti. 2001. Aquatic insect ecology. Pages 733-775 *in* J.H. Thorp and A.P. Covich, editors. Ecology and classification of North American freshwater invertebrates. Academic Press, San Diego, California.

Hynes, H.B.N. 1970. The ecology of running waters. University of Toronto Press, Toronto, Ontario. 555 p.

Hyslop, E.J. 1980. Stomach content analysis: a review of methods and their applications. Journal of Fish Biology 17(4):411-429.

Kamler, J. F. and K.L. Pope. 2001. Nonlethal methods of examining fish stomach contents. Nebraska Cooperative Fish & Wildlife Research Unit -- Staff Publications. Paper 55. http://digitalcommons.unl.edu/ncfwrustaff/55

Keup, L.E. 1988. Invertebrate fish food resources of lotic environments. Instream Flow Information Paper No. 24. U.S. Fish and Wildlife Service Biological Report 88(13). 96 pp.

Klemm, D.J., P.A. Lewis, F. Fulk, and J.M. Lazorchak. 1990. Macroinvertebrate field and laboratory methods for evaluating the biological integrity of surface waters. EPA/600/4-90/030, Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio.

Klemm, D.J., J.M. Lazorchak, and D.V. Peck. 2000. Section 9. Benthic Macroinvertebrates *in* J.M. Lazorchak, B.H. Hill, D.K. Averill, D.V. Peck, and D.J. Klemm, editors. Environmental monitoring and assessment program – surface waters: Field operations and methods for measuring the ecological condition of non-wadable rivers and streams. EPA/620/R-00/007, U.S. Environmental Protection Agency, Cincinnati, Ohio.

Mackay, R.J. 1992. Colonization by lotic macroinvertebrates: a review of processes and patterns. Canadian Journal of Fisheries and Aquatic Sciences 49: 617-628.

Major, E.B., and M.T. Barbour. 2001. Standard operating procedures for the Alaska Stream Condition Index: A modification of the U.S. EPA rapid bioassessment protocols, 5th edition. Prepared for the Alaska Department of Environmental Conservation, Anchorage, Alaska.

Miyake, Y., T. Hiura, N. Kuhara, and S. Nakano. 2003. Succession in a stream invertebrate community: A transition in species dominance through colonization. Ecological Research 18: 493-501.

Moulton, S. R. II, J. G. Kennen, R. M. Goldstein, and J. A. Hambrook. 2002. Revised protocols for sampling algal, invertebrate, and fish communities as part of the national water-quality assessment program. USGS Open-File Report 02-150. U.S. Geological Survey, Reston, Virginia.

Peck, D.V., A.T. Herlihy, B.H. Hill, R.M. Hughes, P.R. Kaufmann, D.J. Klemm, J.M. Lazorchak, F.H. McCormick, S.A. Peterson, P.L. Ringold, T. Magee, and M. Cappaert. 2006. Environmental Monitoring and Assessment Program – Surface Waters Western Pilot Study: Field Operations Manual for Wadeable Streams. EPA/620/R-06/003. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

Petts, G.E. 1984. Impounded rivers: perspectives for ecological management. John Wiley & Sons, New York.

Reice, S.R. and M. Wohlenberg. 1993. Monitoring freshwater benthic invertebrates and benthic processes: Measures for assessment of ecosystem health. Pages 287-305 *in* D.M. Rosenberg and V.H. Resh, editors. Freshwater biomonitoring and benthic macroinvertebrates. Routledge, Chapman and Hall, Inc., New York, New York.

Riis, J. 1975. Pre-authorization assessment of the proposed Susitna River Hydroelectric Projects: Preliminary investigations of water quality and aquatic species composition.

Prepared for the U.S. Fish and Wildlife Service, Anchorage, Alaska. Alaska Department of Fish and Game. APA Document 1611.

Riis, J.C. 1977. Pre-authorization assessment of the proposed Susitna River Hydroelectric Projects: Preliminary investigations of water quality and aquatic species composition. Prepared for the U.S. Fish and Wildlife Service, Anchorage, Alaska. Alaska Department of Fish and Game. APA Document 1610

Robinson, C.T., G.W. Minshall, and S.R. Rushforth. 1990. Seasonal colonization dynamics of macroinvertebrates in an Idaho stream. Journal of the North American Benthological Society 9(3): 240-248.

Saltveit, S.J., J.E. Brittain, and A. Lillehammer. 1987. Stoneflies and river regulation – a review. Pages 117-129, *in* J.F. Craig and J.B. Kemper, editors. Regulated Streams: Advances in Ecology. Plenum Press, New York.

Shaw, D.W. and G.W. Minshall. 1980. Colonization of an introduced substrate by stream macroinvertebrates. Oikos 34: 259-271.

Smock, L.A. 1996. Macroinvertebrate movements: Drift, colonization, and emergence. Pages 371-390 *in* F.H. Hauer and G.A. Lamberti, editors. Methods in stream ecology. Academic Press, San Diego, California.

Trihey and Associates. 1986. Close-out status report for invertebrate analysis. Prepared for Alaska Power Authority. APA Document 3404

Townsend, C.R. and A.G. Hildrew. 1976. Field experiments on the drifting, colonization and continuous redistribution of stream benthos. Journal of Animal Ecology 45(31): 759-772.

U.S. Fish and Wildlife Service. 2012. Letter to the Federal Energy Regulatory Commission, subject: Scoping Comments, Recommendations and Study Requests Notice of Intent to File License Applications; Filing of Pre-Application Document; Commencement of Licenseing Proceeding and Scopeing; Request for Comments on the Pre-Application Docment and Scoping Document 1, and Identifcation of Issues of Associated Study Requests for the Susitna-Watana Hydoelectric Projects 14241-000. Enclosure 11 River Productivity Study Request, dated May 31, 2012

Vannote, R.L., G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37: 130-137.

Wallace, J.B. and J.W. Grubaugh. 1996. Transport and Storage of FPOM. Pages 191-215 *in* F.H. Hauer and G.A. Lamberti, editors. Methods in stream ecology. Academic Press, San Diego, California.

Wallace, J.B. and J.R. Webster. 1996. The role of macroinvertebrates in stream ecosystem function. Annual Review of Entomology 41: 115-139.

Ward, J.V. 1976. Effects of flow patterns below large dams on stream benthos: a review. Pages 235-253 *in* J.F. Orsborn and C.H. Allman, editors. Instream flow needs symposium, volume II. American Fisheries Society, Bethesda, Maryland.

Ward, J.V. and J.A. Stanford. 1979. Ecological factors controlling stream zoobenthos with emphasis on thermal modification of regulated streams. Pages 215-236 *in* J. V. Ward, and

J. A. Stanford, editors. The Ecology of Regulated Streams. Plenum Press, New York, New York.

Waters, T.F. 1972. The drift of stream insects. Annual Review of Entomology 17: 253-272.

Williams, D.D. and H.B.N. Hynes. 1977. Benthic community development in a new stream. Canadian Journal of Zoology 55: 1071-1077.

7.8.9. Tables

Table 7.8-1. Preliminary macroinvertebrate and algae sampling sites, stratified by reach and habitats. Refer to Figures 7.8-1 – 7.8-3 for locations of the preliminary reaches.

Sampling Reach	Reach Description	Number of Mainstem Sites	Number of Associated Off-channel Sites[1]
Upper Reach			
UR-1 or -2	Reference upstream of reservoir	1	2
UR-3 or -4	Reservoir tail (transitional area)	1	2
UR-6	Within reservoir pool	1	2
Middle Reach			
MR-1	Immediately below dam site	1	2
MR-2	Upstream of Devils Canyon	2	4
MR-6	Downstream of Devils Canyon	1	2
Lower Reach			
LR-1	Below 3 River Confluence	2	4
Susitna River Totals		**9**	**18**

Notes: 1 Side-channels, sloughs, tributary confluences associated with a mainstem sampling site.

Table 7.8-2. Preliminary schedule for River Productivity Study.

Activity	2012				2013				2014			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Literature Review on Hydropower Impacts			--------	-------								
Sampling benthic macroinvertebrate communities, algal communities, and organic matter.					▲-	--▲---	▲-▲		----▲-	--▲---	▲-▲	-----
Invertebrate drift sampling					▲-	--▲---	▲-▲		----▲-	--▲---	▲-▲	-----
Literature search of existing river systems							--------	--------				
Review on the feasibility of a trophic analysis							--------	--------				
Generate habitat suitability criteria									--------	--------	--------	-----
Conduct a fish gut analysis					▲-	--▲---	▲-▲		----▲-	--▲---	▲-▲	-----
Establish baseline colonization rates					▲-	▲-	▲-▲		▲-	▲-	▲-▲	
Data Analysis and Reporting				-----●		-----●	--------	---●--	--------	-----●	--------	---●
Initial Study Report								-----●				
Updated Study Report												-----●

7.8.10. Figures

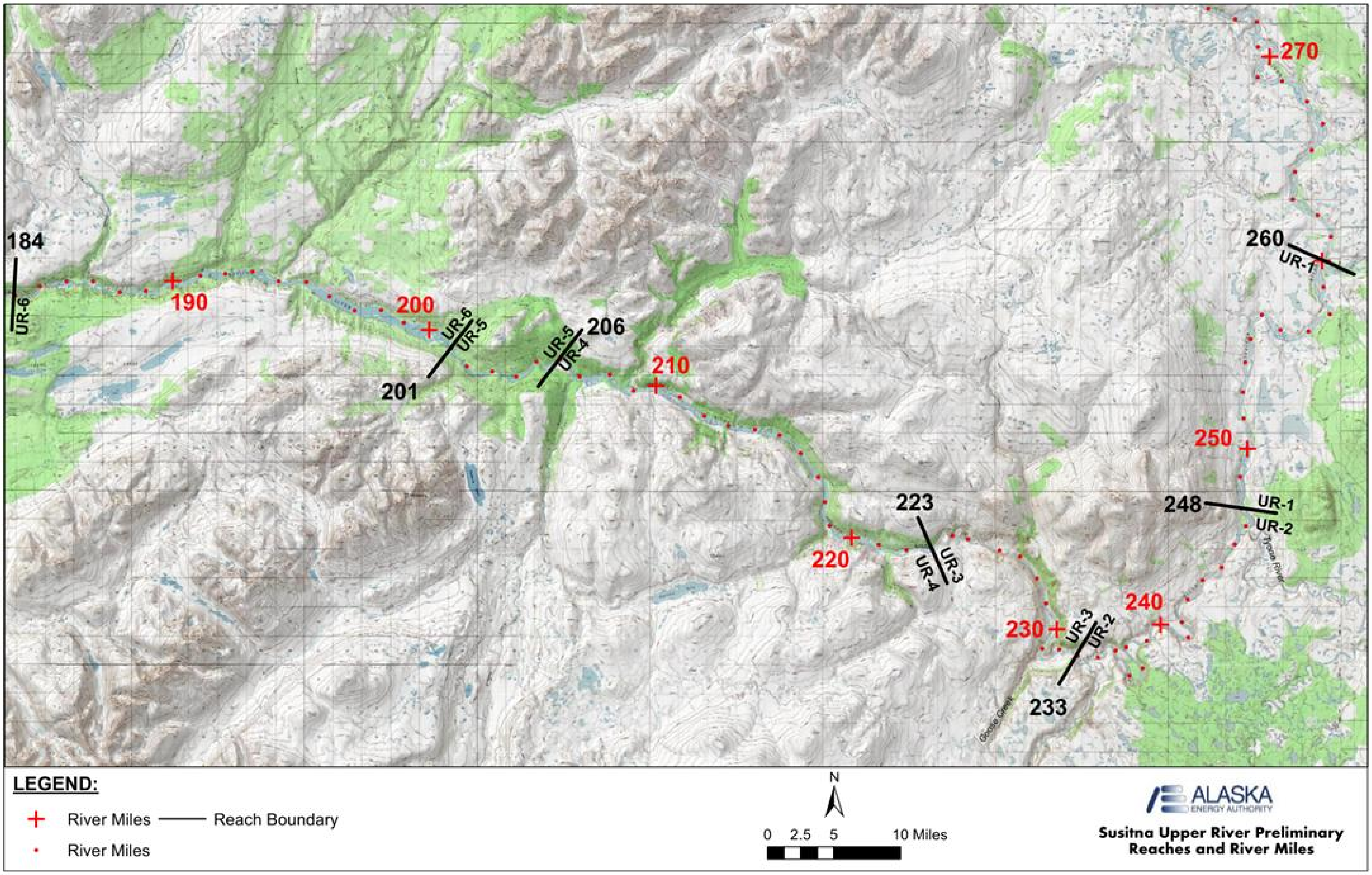


Figure 7.8-1. Upper Susitna River Reach, Preliminary Reaches and River Miles.

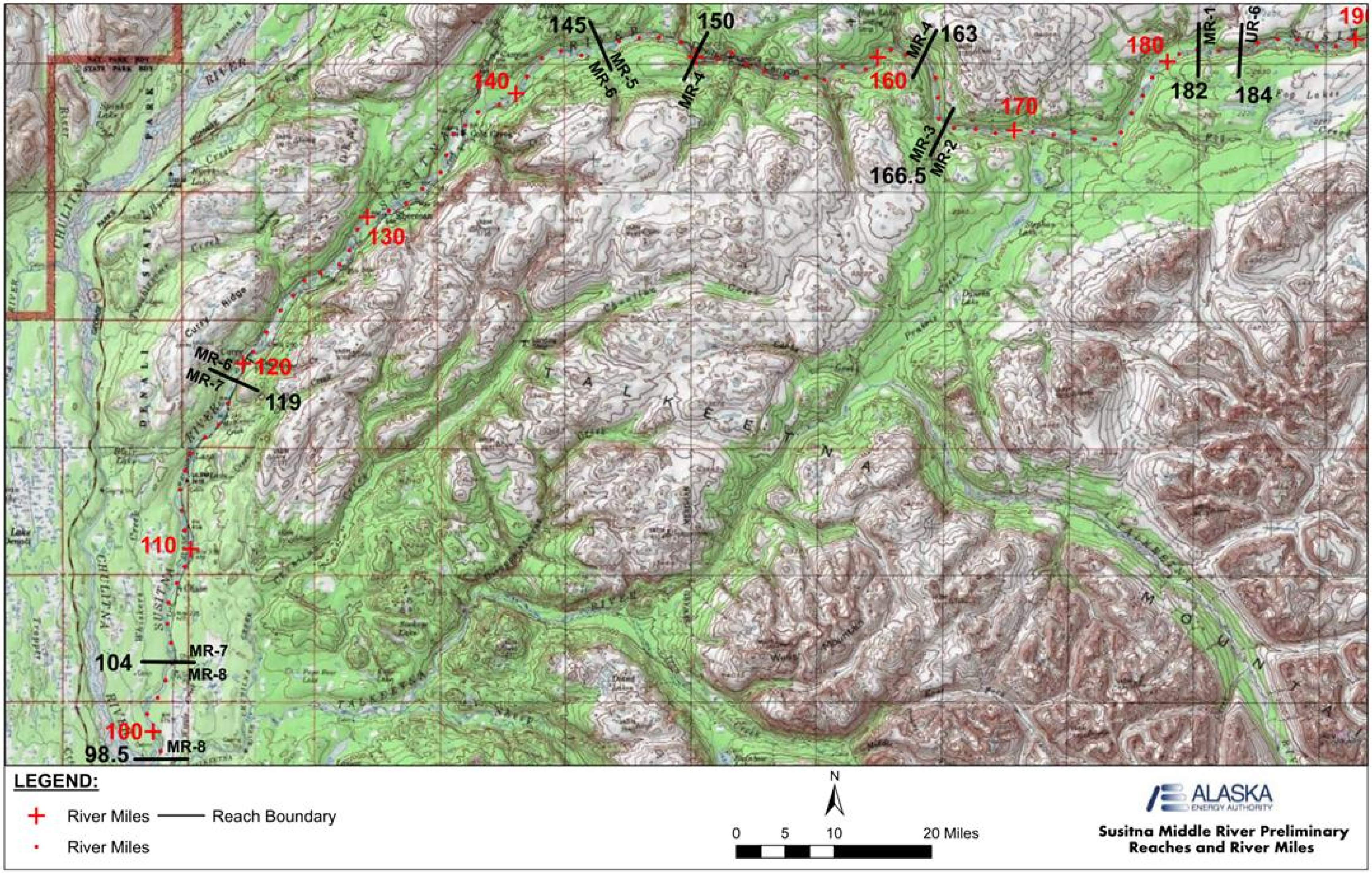


Figure 7.8-2. Middle Susitna River Reach, Preliminary Reaches and River Miles.

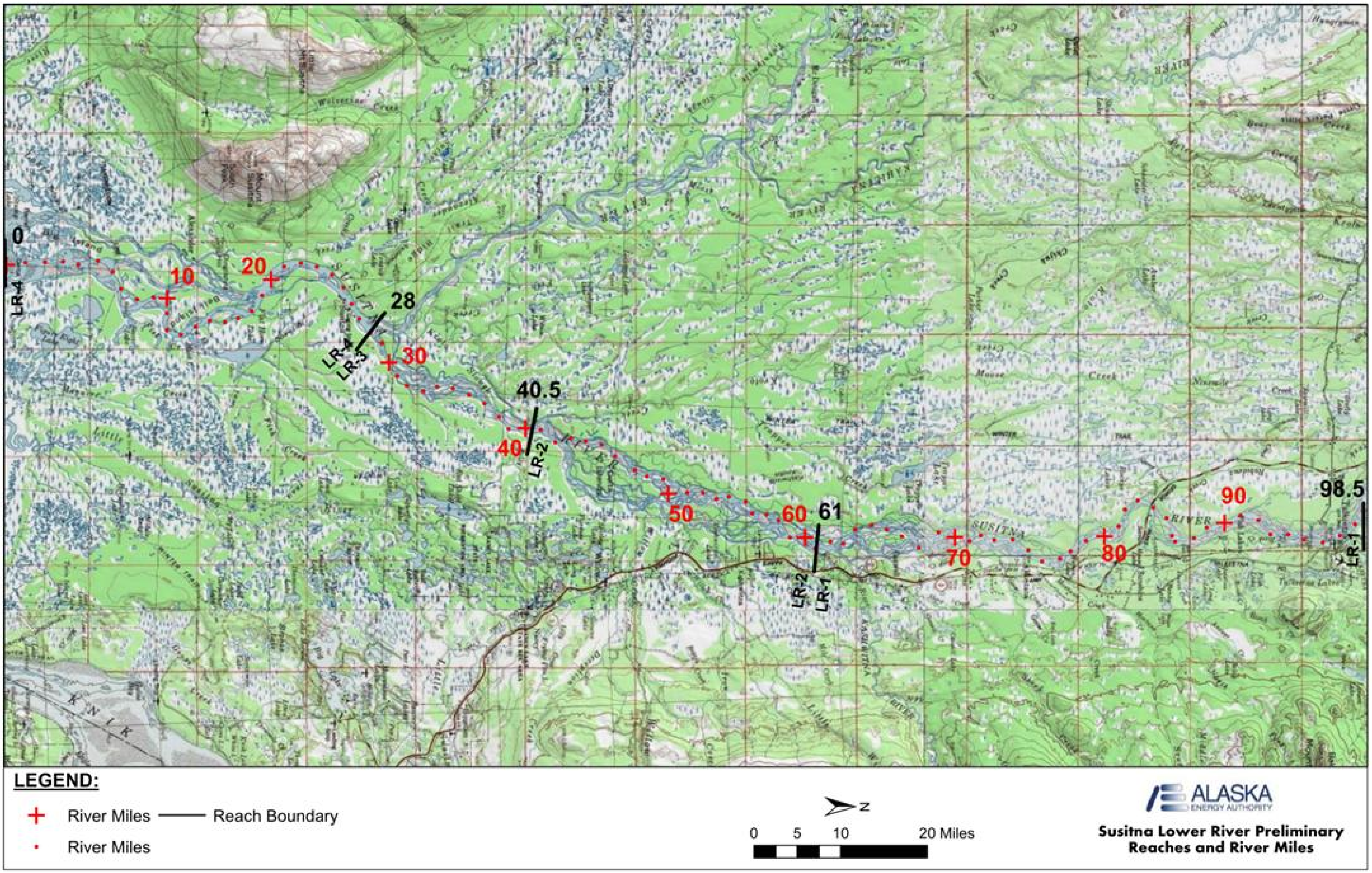


Figure 7.8-3. Lower Susitna River Reach, Preliminary Reaches and River Miles.

7.9. Characterization of Aquatic Habitats in the Susitna River with Potential to be Affected by the Susitna-Watana Project

7.9.1. General Description of the Proposed Study

This is a multi-year study that will provide a baseline characterization of aquatic habitats as they currently exist. Due to the complex nature of the Susitna River the study will characterize habitats at different scales related to degree of potential impact. For example, detailed field surveys will be conducted in the reservoir inundation zone whereas remote videography will be the primary method for habitat characterization of mainstem habitats in the lower river. This study will be valuable for gathering baseline habitat data that can be used along with other data being gathered (e.g. fish distribution and abundance, water surface elevation and discharge relationships, instream flow modeling, flow routing) to assess potential impacts associated with Project operations.

7.9.1.1. Study Goals and Objectives

Construction and operation of the Project will modify the aquatic habitat in the area inundated by the Project reservoir and has the potential to alter aquatic habitats in the mainstem channel of the Susitna River downstream from the Project dam, including along channel margins, at tributary confluences, at the inlets and outlets to side channels sloughs, and off-channel waterbodies in the zone of hydrologic influence. The goal of this study is to characterize all aquatic habitats with the potential to be altered and/or lost as the result of reservoir filling, hydropower operations, and associated changes in flow, water surface elevation, sediment regime, and temperature. The objectives of this study are as follows.

1. Characterize the existing upper mainstem Susitna River and tributary habitat within the proposed inundation zone.
2. Characterize the middle (RM 98 to RM 184) and the lower (RM 28 to RM 98) mainstem Susitna River channel margin and off-channel habitats using the Susitna-Watana Project habitat classification system and standard USFS protocols, with modifications to accommodate site-specific habitats.
3. Characterize the tributary and lake habitat upstream from the proposed Watana Dam site to the Oshetna River (RM 184 to RM 233.4) that is currently accessible to fish from the Susitna River or that would be accessible due to inundation of existing fish passage barriers after the reservoir is filled.

7.9.2. Existing Information and Need for Additional Information

During the 1980s study efforts, habitat characterization in the middle reach of the mainstem Susitna River was conducted at a relatively coarse scale; mainstem habitat types that were representative of distinct functional hydrology were identified. Under this system, the Susitna River was classified into seven mainstem habitat types: mainstem channel, side channel, side slough, upland slough, tributary mouth, tributary, and lakes, defined by source water and hydrologic connectivity (Trihey 1982, ADF&G 1983a). For example, side channels were described as side channels that carried less than 10 percent of the mainstem flow, whereas sloughs were identified as having a water source derived from some combination of groundwater, tributaries, and/or local runoff. Upland sloughs, unlike side sloughs, were those that were disconnected from mainstem flows at their heads. These seven mainstem habitat types were mapped in the middle and lower river based on aerial photography and were given individual alpha-numeric identifiers such as "Slough 22" (ADF&G 1983a). Subsequent sampling of fish populations and collection of water quality and habitat suitability data were conducted in subsets of the mapped habitats. Additional habitat characterization efforts developed during the 1980s defined unique categories of river habitat based on clear or turbid water conditions under specific flows ,in combination with presence or absence of open water leads during winter (Steward and Trihey 1984) or hydrologic zones (ADF&G 1983a, ADF&G 1983b). The habitat categories were focused on main channel and side channel habitats in intensively studied areas in an attempt to scale the information up to the entire Middle Susitna River Reach for simulating the relationship between habitat and flow.

Very little habitat information has been collected in the upper Susitna River. In the early 2000s, ADF&G conducted sampling in the upper Susitna River sub-basin as part of its Alaska Freshwater Fish Inventory (AFFI) program (Buckwalter 2011a). These surveys were focused on documenting fish presence and collecting reach-level habitat data in medium and large tributary drainages (Buckwalter 2011b). The AFFI habitat studies were conducted at a scale that is not necessarily informative for understanding impacts to fish use or productivity. Because the upper river surveys were focused on fish inventory, they applied a dispersed sampling design, that covered 60 streams; however, habitat data were collected at only one transect per stream. The scale of these historic data collection efforts limits their applicability for evaluating fish-habitat relationships and the potential for changes in fish habitat use throughout the Susitna River as a result of hydropower facility development and operation.

To augment the historic habitat data, we propose to first characterize aquatic habitat at the meso-habitat level within mainstem and tributary habitats. Characterization of mesohabitats is important in assessing potential impacts to fish populations because it is at this level that fish selectively use different habitats (Hardy and Addley 2001) to support different life stages and life functions. A full complement of meso-habitat types is required to sustain multiple life stages, support a diverse fish community, and furthermore, the distribution of these habitats throughout the river will influence fish distributions. Fine scale habitat attributes, such as those found at the meso-habitat level are thought to be particularly relevant to aquatic organisms. Organisms interact with their environment at different scales depending on their size and mobility (Parasiewicz 2007), both of which change with growth and development. Parasiewicz (2007) further suggested that mesohabitats are habitats within which an organism can be observed for a significant portion of its daily routine, similar to functional habitat discussed by Kemp (1999). For this study, information will be collected to support the development of habitat descriptions at more ecologically significant scales by considering several attributes that are biologically important to fishes (Harper et al. 1992, Maddock 1999). The higher mainstem habitat classifications used in the 1980s will be retained to allow for some level of comparison over time.

In addition to considering the scale of habitat classification, it is also important to consider the use of an objective classification approach that not only captures existing site-specific characteristics, but also can be used for comparisons across space and time. Meso-habitat assessments based on river morphology and ecologically significant habitat attributes should be consistent and reproducible. The USFS Aquatic Habitat Surveys Protocol (USFS 2001) is an example of a standardized protocol that was developed in Alaska to facilitate creation of a regional stream habitat database as well as one that allows for aggregation of habitat data at multiple scales.

A Susitna River-specific hierarchical classification system is currently under development by the Fish and Aquatics TWG. In its current draft form, the classification system has two components: one for the Susitna River upstream of the proposed Watana dam site and another for the middle and lower Susitna River below Devils Canyon (Figure 7.9-1). The Susitna River classification system combines the historic approach to mainstem habitat classification and a modified version of the meso-habitat classification system from the USFS Aquatic Habitat Surveys Protocol (USFS 2001). This hybrid classification system will describe habitats that are defined by the unique hydrology of this river system, yet are significant to the day-to-day function and behavior of fish and aquatic organisms.

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

- **F1:** Effect of change from riverine to reservoir lacustrine habitats resulting from Project development on aquatic habitats, fish distribution, composition, and abundance, including primary and secondary productivity.
- **F2:** Potential effect of fluctuating reservoir surface elevations on fish access and movement between the reservoir and its tributaries and habitats.
- **F4:** Effect of Project operations on flow regimes, sediment transport, temperature, and water quality that result in changes to seasonal availability and quality of aquatic habitats, including primary and secondary productivity. The effect of Project-induced changes include stream flow, stream ice processes, and channel morphology (streambed coarsening) on anadromous fish spawning and incubation habitat availability and suitability in the mainstem and side channels and sloughs in the Middle River above and below Devils Canyon.
- **F7:** Influence of Project-induced changes to mainstem water surface elevations from July through September on adult salmon access to upland sloughs, side sloughs, and side channels.
- **F9:** The degree to which Project operations affect flow regimes, sediment transport, temperature, water quality that result in changes to seasonal availability and quality of aquatic habitats, including primary and secondary productivity.

The information collected during this study will be essential to understanding fish habitat use and will provide information relevant to addressing the five potential fisheries issues listed above.

7.9.3. Study Area

The study area encompasses two sections of the Susitna River. The upstream section includes mainstem and tributary habitats from the confluence with the Oshetna River (RM 233.4) to the upstream end of Devils Canyon (see Figure 7.5-1). The downstream section includes the potential zone of Project hydrologic influence in the mainstem river from the downstream end of

Devils Canyon (RM 150) to the upper extent of tidal influence at approximately RM 28 (see Figure 7.5-1).

7.9.4. Study Methods

The Susitna River from the Oshetna River to the intertidal zone includes approximately 200 miles of mainstem channel and likely more than double that distance when the lengths of side channels and sloughs are included. Given the linear extent and remoteness of the river, an approach that combines analysis of aerial imagery with ground-based collection of habitat data will be used. This combination of methods will allow for maximizing coverage of river habitats in concert with efficient collection of detailed data at selected habitats suitable for ground surveys. Furthermore, the habitat characterization methods can be tailored to accommodate variations in channel size and overall stream length. All habitat data collected in this study will be consistent with the Susitna-Watana Project habitat classification system and modified from standard protocols outlined in the USFS Aquatic Habitat Surveys Protocol (USFS 2001).

7.9.4.1. Habitat Characterization Using Remote Imagery

Habitat can be efficiently typed and delineated using remote images such as quality video or aerial photography. Remote habitat typing allows for greater spatial coverage of aquatic habitats than ground-based surveys, as well as the ability to gather data on areas inaccessible by foot or boat. However, both weather and site-specific conditions, such as vegetative cover, can affect the quality of the video and, therefore, the utility of this method.

Video imagery is being collected in 2012 upstream of the proposed Watana Dam site. Imagery will cover the mainstem channel and larger tributaries with a sufficiently open canopy to allow for delineation of river habitats. This initial effort will be limited to selected tributaries to evaluate the effectiveness of video imagery. Video imagery will be collected at a resolution sufficient to allow for delineation at the meso-habitat level as well as remote collection of certain habitat attribute data such as large woody debris and dominant substrate. This effort will be continued in 2013 to provide complete coverage of upper mainstem and tributary habitats where Project affects are possible.

Due to the size and complexity of the middle and lower river, habitat characterizations will be conducted at different scales. The initial focus in 2013 will be to collect video imagery that supports the delineation of both mainstem and meso-habitats in the Middle River along the river's channel margins from Devils Canyon to the Chulitna River. In 2013, a reconnaissance survey will also be conducted in portions of the Lower River Reach to determine the feasibility of documenting all channel margin habitat with slightly lower resolution video than that proposed for the Middle River Reach. If it proves infeasible to obtain quality video coverage of this extensive area, then a systematic subsampling scheme that focuses on representative channel types will be proposed within reaches where Project impacts are anticipated.

Aerial videography will be collected using low elevation helicopter flights. Video equipment will consist of a high resolution camera with an integrated GPS. Video will be collected by an experienced senior technician during a period of low flows and high water clarity, which is anticipated to occur in mid to late September. The video will be shot from the right rear of a helicopter with its cabin door removed to maximize direct viewing. A narrator/navigator will be positioned in the left front next to the pilot. The video will be shot from an elevation of approximately 100 to several hundred feet to allow for safe navigation and sufficient resolution. The imagery will be post-processed into a navigable video that will include a GPS stamp to reference the location on topographic maps or with existing aerial imagery. Video stills will also be collected to expand the Project's aerial imagery resources and to support habitat mapping efforts.

The video will be supplemented with existing LiDAR and aerial imagery from the Matanuska-Susitna Borough LiDAR and Imagery Project for delineating and mapping the seven mainstem habitat types developed during the 1980s as well as mesohabitats contained within these larger mainstem units (Table 7.9-1). The distribution and frequency of mainstem and meso-habitat types will be documented. If demonstrated to be effective during the 2012 study, aerial video mapping will be preferentially used where there is no canopy or topographic cover obscuring the river channel. However, because some tributary habitats may not be visible from the air due to thick overhead vegetation, steep topographic relief, or small channel size, tributary assessments may rely more heavily upon ground-based mapping in accessible segments or a combination of both video and ground-based surveys. Ground-based data will also be collected for a subset of video delineated units to calibrate remote mapping techniques.

Mesohabitats 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 meso-habitat length; for example, sections with short habitat units will be based on 3-second intervals, while sections with long habitat units will be based on 5-second intervals.

Video mapping will be initiated in the upper Susitna River in 2012. Aerial video imaging activities for 2013 will be implemented based on a review of the results and effectiveness of the 2012 effort. It is anticipated that any refinement will be coordinated with the TWG and licensing participants. Further, additional coordination with other study teams may be conducted to help refine study methods and benefit or supplement data gathering activities in other resource areas.

7.9.4.2. Ground-Based Habitat Surveys

Whereas the remote habitat mapping will be applied to the entire study area, ground-based surveys will be focused on collecting data in the upper mainstem river and tributaries and the middle mainstem river since these reaches can be effectively and safely surveyed by boat or by foot. Additionally, as mentioned above, some ground-truthing of video-delineated habitat units will be completed to increase the accuracy of video delineations. Although comprehensive sampling is desired, the extensive stream network in the upper and middle river likely will prevent continuous coverage of all mainstem reaches and tributaries. Thus, a subsampling approach will be necessary.

Subsampling will be implemented at the mainstem habitat level based on all mainstem habitat units delineated in the upper and middle river. Mainstem habitat units to be surveyed will be randomly selected at a frequency of every X^{th} side channel, tributary mouth, upland slough, etc. For each mainstem unit selected, field crews will conduct a continuous survey of meso-habitat units contained within.

In the upper river, we will attempt to conduct continuous stream surveys for all tributary habitats within the inundation zone up to an elevation of 2,200 feet using the sampling approach described above. For Chinook salmon-bearing streams, a subsampling approach will be used to characterize the habitat above the inundation zone upstream to approximately 3,000 feet elevation or the first fish passage barrier. If tributaries are identified where access may become available to migratory fish as a result of Project construction and creation of the reservoir at a maximum normal pool elevation above 2,050 feet msl, the entire tributary will be surveyed by stratifying reaches based on channel morphology and within these strata, randomly subsampling meso-habitat units as described above.

Habitats will be mapped to the meso-habitat level in accordance with the channel typing and aquatic habitat classification system currently under development for the Project by the Fish and Aquatic TWG (Table 7.9-1). Mesohabitat units will be typed based on a modified) USFS Tier III stream habitat survey protocol (2001). Some sections of stream may contain two or more different habitat units in parallel; in these cases primary and secondary units will be designated.

Aquatic habitat surveys will be conducted by two-person survey crews. Each survey crew will consist of a fish biologist and qualified fisheries technician. In wadeable streams, surveys will generally begin at a tributary confluence or a predetermined location with data collection progressing in an upstream direction. Boat surveys will be conducted by boat and will be limited to stream segments where flow conditions and channel size preclude the ability to conduct wadeable surveys. If permanent impassable barriers are encountered within the 2,200 elevation point, the barriers will be documented and surveys will continue upstream to the survey end. If a permanent impassable barrier is encountered above the 2,200 elevation point surveys will end at that location.

Field habitat surveys conducted for this study include three components:

1. A reach-scale description of channel morphology;
2. A stream survey consistent with the USFS Tier III survey (USFS 2001); and
3. Location and description of special habitat features.

7.9.4.3. Channel Morphology

The USFS developed a protocol using a hierarchical habitat classification system to provide consistent databases based on the same framework to allow for comparisons within a single system and comparisons to data for other streams (USFS 2001). At the highest level, the Tier I survey incorporates information on channel morphology and valley form. Channel morphology data provide a foundation for understanding the channel forming processes that drive the distribution and abundance of distinct aquatic habitat types. Furthermore, this information can provide process-based context for interpreting future responses of the stream channel to perturbations. A reach is defined as a section of channel that has consistent channel morphology and flow volume. Reaches delineated for this study will be a minimum of 100 meters in length. The start and end points of each reach will be georeferenced using GPS. Reach-scale channel morphology variables to be measured or calculated for this survey include:

- Bankfull width;
- Bankfull depth;

- Gradient;
- Channel pattern;
- Channel type;
- Substrate D16, D50, D84 (calculated from pebble count); and
- Sinuosity (calculated).

Reaches will be delineated by a significant change in reach-scale geomorphology (e.g., channel type, gradient, major tributary junction). Channel morphology measurements are conducted at the reach scale and from fast water habitat units only, as those features tend to have a channel geometry that reflects reach-scale flow and geomorphic processes. If major side channels are present throughout the reach, channel morphology measurements (i.e. bankfull width) should be extended to include those features. Reach scale data will be measured at least three times per reach.

Bankfull width will be measured using a 50-meter (164-foot) Kevlar tape or calibrated laser rangefinder. The maximum depth relative to the bankfull flow level will be measured using a graduated wading rod or stadia rod. Gradient will be measured using a clinometer over a distance of at least 20 bankfull widths at each site where bankfull width and depth data are collected. Substrate will be characterized once per reach at a representative riffle segment by conducting a Wolman pebble count (Wolman 1964). Pebble count data will be used to calculate the D_{16}, D_{50} and D_{84} particle sizes. Sinuosity will be calculated during data entry as the ratio of channel thalweg length (i.e. survey distance) to valley bottom length (i.e. straight line distance between reach start and endpoints).

Reach scale channel morphology data will be recorded on the channel morphology field data form. One channel morphology form will be completed for each mainstem habitat unit. Copies of all field forms are provided in Appendix 1.

7.9.4.4. Tier III Meso-habitat Survey

Stream survey data are used to describe aquatic habitats at the meso-habitat scale. Habitat data will be recorded on the stream survey field data form. Separate stream survey data sheet(s) will be completed for each reach. Habitat parameters to be measured for this component of the study include:

- Habitat unit type (See Table 7.9-1);
- Habitat unit length;
- Average wetted width (3 measurements per unit);
- Percent substrate composition;
- Length of undercut bank;
- Dominant riparian vegetation type; and
- Cover.

Habitat units will be sequentially numbered as they are encountered during each survey, and data will be recorded for each habitat unit. Data collected for all habitat units will include the unit length, three measurements of wetted width from which an average wetted width will be calculated, percent substrate composition, percent eroding bank on each side of the channel, percent undercut bank on each side of the channel, dominant riparian vegetation type, cover type, and cover percent. For fastwater habitats, data will be visually estimated for each unit, and measured in every fifth unit of each individual fastwater habitat type (for example, fifth riffle, fifth run, etc.) for calibration purposes.

Additional data will be recorded for pool habitat units. The type and amount of overhead cover will be visually assessed and recorded. The maximum pool depth and depth at the pool tail crest will be measured to the nearest 0.1 foot. These data will be used to calculate residual pool depth. The structural feature responsible for forming the pool will be identified (e.g., boulder, undercut bank, large or small wood).

Split channels are defined as separate flow paths located within the bankfull channel and separated from each other by gravel bars that are barren or support only annual vegetation. When split flow is encountered, each split will be surveyed and the proportion of flow conveyed by the split will be estimated, recorded, and used to classify each channel as primary (majority of the flow) or secondary (minority of the flow). Habitat units in the split that convey the most flow will be designated primary units and will continue to be numbered sequentially as part of the main channel survey. Split flow channels transmitting less flow will be designated as secondary units and will be differentially numbered (e.g. SP1-1, SP1-2, etc).

Side channels are defined as features with a fluvially-sorted mineral bed that are separated from the main channel by an island that is at least as long as the main channel bankfull width and that supports permanent vegetation. At a minimum, the inlet and outlet of each side channel will be documented by collecting a GPS waypoint and taking a photograph looking upstream from the outlet and downstream from the inlet. The side channel will be identified as entering from the left or right bank (looking downstream) and classified as wet or dry. Habitat data will be collected in wetted side channels according to the methodology described above. Side channels will be labeled SC-LB1, SC-RB2, etc. in the order they are encountered.

7.9.4.5. Special Habitat Features

Special habitat features include tributary channels, seeps and springs that contribute groundwater to the mainstem, and temporary (e.g. subsurface flow) or permanent barriers to upstream fish migration. A separate data sheet will be maintained for each reach listing the type, location, and a description of special habitat features.

For features classified as stream barriers, the following information will be recorded in the comments section:

- Barrier type (beaver dam, debris dam, vertical falls, chute/cascade, boulder, other);
- Temporal nature (ephemeral or permanent);
- Maximum height of falls or biggest single step if cascading;
- Maximum depth of plunge pool;
- Chute/cascade gradient and length; and
- Length of feature.

A GPS waypoint and a photograph will be taken of each special feature. Additional photographs will be taken of representative channel conditions throughout each reach. The photo number, waypoint, date, and associated habitat unit or feature number will be recorded for each photograph.

The characterization of habitats will be complemented by the Instream Flow Study (ISF) habitat suitability and transect data collection efforts (See Section 6.5), as well as several fish population studies. All remote video imaging and the majority of field sampling associated with this study are intended to occur in 2013. In 2014, additional fieldwork for habitat characterization and validation will be conducted, as necessary, and the potential effects to habitats resulting from Project operations will be modeled. Information gathered from this study will be provided to the ISF team for modeling of potential changes; hence, this study requires close coordination with the ISF team.

7.9.5. Consistency with Generally Accepted Scientific Practices

Studies to map and characterize aquatic habitats are commonly conducted during water resource development projects, including for hydroelectric projects as part of FERC licensing. Field studies will use protocols developed in consultation with agency representatives and modified from standard federal protocols developed for use in Alaska (USFS 2001) and be consistent with the ISF analysis. Remote mapping will utilize protocols similar to those performed at other hydroelectric projects.

7.9.6. Schedule

Habitat characterization of the upper Susitna River will begin in 2012. Ground-based surveys will be conducted from July through September in 2012 and 2013. Flights for video data collection will be conducted in mid- to late-September 2012. Analysis of the video and habitat typing will occur simultaneously with data management for field survey data from October through December 2012 and 2013.

The following tentative schedule is for the significant 2012-2014 work products.

- Year-1 Study Implementation — July-October 2012
- 2012 Annual Project Report — December 2012
- Year-2 Study Implementation — July-October 2013
- Initial Study Report — December 2013
- Updated Study Report — December 2014

7.9.7. Level of Effort and Cost

The total estimated cost of the study for 2013 and 2014 is $2,000,000. The first year is estimated to cost $600,000, including videography, initial field surveys, and data management. The second year is estimated to cost $1,400,000, including follow up field surveys, data analysis and technical report preparation.

7.9.8. Literature Cited

ADF&G. 1983a. Su Hydro draft basic data report, volume 4, part 1. ADF&G Su Hydro Aquatic Studies Program, Anchorage, Alaska.

ADF&G (Alaska Department of Fish and Game). 1983b. Resident and juvenile anadromous fish studies on the Susitna River below Devil Canyon, 1982. Susitna Hydro Aquatic Studies. Phase II Basic Data Report. Volume 3. Prepared for Alaska Power Authority, Anchorage, Alaska.

AEA (Alaska Energy Authority). 2011a. Aquatic Resources Gap Analysis. Prepared by HDR, Inc., Anchorage. 107 pp.

AEA. 2011b. Pre-application Document: Susitna-Watana Hydroelectric Project FERC Project No. 14241. December 2011. Prepared for the Federal Energy Regulatory Commission, Washington, DC.

Buckwalter, J.D. 2011a. Synopsis of ADF&G‘s Upper Susitna Drainage Fish Inventory, August 2011. November 22, 2011. ADF&G Division of Sport Fish, Anchorage, AK. 173 pp.

Buckwalter, J.D. 2011b. Station Reports. August 2001. ADF&G Division of Sport Fish, Anchorage, AK. 146 pp.

Hardy, TB and R.C. Addley. 2001. Vertical integration of spatial and hydraulic data for improved habitat modelling using geographic informationsystems. In Hydroecology: Linking hydrology and aquatic ecology. Proceedings of the Birmingham, United Kingdom Workshop, Acreman MC (ed.). July 1999. IAHS Publication No. 266, 65–75.

Harper DM, Smith CD, Barham PJ. 1992. Habitats as the building blocks for river conservation assessment. In River Conservation and Management, Boon PJ, Calow P, Petts GE (eds). John Wiley: Chichester; 311–319.

Kemp JL, Harper DM, Crosa GA. 1999. Use of ‘functional habitats’ to link ecology with morphology and hydrology in river rehabilitation. Aquatic Conservation: Marine and Freshwater Ecosystem 9(1): 159–178.

Maddock, I. 1999. The importance of physical habitat assessment for evaluating river health. Freshwater Biology 41: 373-391.

Moore, K. M. S., K. K. Jones, and J. M. Dambacher. 2006. Aquatic Inventories Project: Methods for Stream Habitat Surveys. Oregon Department of Fish and Wildlife, Corvallis, Oregon.

Parasiewicz, P. 2007. The MesoHABSIM model revisited. River Research and Application 23: 893-903.

Peterson, N.P. and L.M. Reid. 1984. “Wall-base channels: their evolution, distribution and use by juvenile coho salmon in the Clearwater River, Washington.” Pages 215–226 *in* J.M. Walton and D.B. Houston, editors. Proceedings of the Olympic Wild Fish Conference: Port Angeles.

Steward, C.R., and E.W. Trihey. 1984. Draft. Fish habitat and instream flow relationships in the middle reach of the Susitna River: an extrapolation methodology. Alaska. Susitna Hydroelectric Project Doc. No. 378. 20 pp.

Trihey, E. W. 1982. Preliminary assessment of access by spawning salmon to side slough habitat above Talkeetna. Susitna Hydroelectric Project Doc. No. 134. 24 pp.

Trihey, E.W. 1984. Response of aquatic habitat surface areas to mainstem discharges in the Talkeetna to Devil Canyon reach of the Susitna River . Alaska. Susitna Hydroelectric Project Doc. No. 1693.15 pp.

U.S. Forest Service (USFS). 2001. Chapter 20 – Fish and Aquatic Stream Habitat Survey. FSH 2090-Aquatic Habitat Management Handbook (R-10 Amendment 2090.21-2001-1).

Woodward-Clyde Consultants, and Entrix, Inc. 1985. Fish Resources and Habitats in the Middle Susitna River. Technical Report No. 1. Instream Flow Relationships Series. Alaska Power Authority Susitna Hydroelectric Project. Vol. 1.

7.9.9. Tables

Table 7.9-1. Susitna River Mainstem and Meso-habitat Type Descriptions.

Classific-ation Level	Type	Description
Mainstem Habitat Type		
	Main Channel	Channels of the river that convey streamflow throughout the year. Can include single or multiple channels. In the Susitna River, they are visually recognizable during summer months by turbid, glacial water and high velocities. In general, they convey more than 10 percent (approximate) of the total flow passing a given location. [1,2]
	Side Channel	Channels that contain streamflows during open water periods but may be dewatered in a portion of the channel or entirely at low flows.[1] These channels carry mainstem water so also may be characterized by turbid, glacial water. Velocities often appear lower than in mainstem sites. In general, they convey less than 10 percent (approximate) of the total flow passing a given location. [1] Side channel habitat may exist in well-defined channels or in areas possessing numerous islands and submerged gravel bars.
	Tributary Mouth	Clear water areas that exist where tributaries flow into Susitna River mainstem or side channel habitats.[1] This habitat type flow often manifests as a clear water plume extending out into the turbid receiving water of the mainstem Susitna River. Tributary mouth habitat also extends upstream into the tributary to the upper extent of any backwater influence that might exist. The surface area of tributary mouth habitat is affected both by tributary discharge and mainstem stage. [2]
	Tributary	Those reaches of tributary streams upstream of the tributary mouth habitats. Tributary habitat may contain distinct mainstem channel types, off-channel waterbodies, and mesohabitat types.
	Off-Channel	Aquatic habitats located beyond a river's active channel, yet still within the river's active valley. Off-channel habitats lack an upstream surface water connection to the main channel at intermediate or low flows, although downstream surface water connections may exist. Off-channel habitats convey water or contain water from small tributaries, upwelling groundwater, and/or local surface runoff.
Off-Channel Type		
	Side Slough	Overflow channels contained within the Susitna River floodplain that are separated from the mainstem at the upstream end by exposed alluvial berm.[1] These channels generally contain clear water from small tributaries, upwelling groundwater, and local surface runoff. Side sloughs have non-vegetated bars at their upstream ends that are overtopped during periods of moderate to high mainstem discharge. The water surface elevation of the mainstem Susitna river at the downstream end of a side slough generally causes a backwater effect in the lower portion of the slough. Overtopping from mainstem flows occurs multiple times for short durations June through August. [1] Except during periods of overtopping the temperature of side sloughs is independent of the mainstem water temperature.
	Upland Slough	Similar to side sloughs except they are separated from the mainstem channel or a side channel by a well vegetated berm. Upland sloughs contain clear water from small streams, upwelling, and/or local surface runoff. Upland sloughs are rarely overtopped by mainstem discharge. [1,2]
	Backwater	Found along channel margins and created by mainstem flow eddies around obstructions such as boulders, root wads, or in-channel wood. Part of active channel at most flows; scoured at high flow. Substrate typically sand, gravel, and cobble. Generally not as long as the full channel width. [3]

Classific-ation Level	Type	Description
	Isolated Pond	A self-contained off-channel waterbody that lacks a surface water connection to the river when the main channel flow is less than bankfull. Substrate is highly variable.
	Relic Channel	An abandoned channel lacking active flow. [5]
Meso-habitat Type		
	Cascade	A fast water habitat with turbulent flow; many hydraulic jumps, strong chutes, and eddies and between 30-80% white water. High gradient; usually greater than 4% slope. Much of the exposed substrate composed of boulders organized into clusters, partial bars, or step-pool sequences. [3]
	Riffle	A fast water habitat with turbulent, shallow flow over submerged or partially submerged gravel and cobble substrates. [3] Gradients are approximately 2 to less than 4%.
	Run	A fast water habitat with little surface turbulence. A run has generally uniform depth that is greater than the maximum substrate size. [3] Gradients are approximately 0 to less than 2%.
	Pool	A slow water habitat with a flat surface slope and low water velocity that is deeper than the average channel depth. Substrate is highly variable. [3]
	Beaver Complex	A complex waterbody created by beaver dams that includes one or more ponded areas, connecting channels, and outlet channel to the mainstem, side or a tributary channel. Substrate is general fine grained sand, silt and organic debris.
Pool Subtypes		
	Scour Pool	Formed by mid-channel scour or flow impinging against one stream bank or partial obstruction (logs, root wad, or bedrock). Generally with a broad scour hole. Includes corner pools in meandering lowland or valley bottom streams. [3]
	Backwater Pool	Found along channel margins; created by eddies around obstructions such as boulders, root wads, or woody debris. Part of active channel at most flows; scoured at high flow. Substrate typically sand, gravel, and cobble. Generally not as long as the full channel width. [3]
	Beaver Pond	Water impounded by the creation of a beaver dam. Maybe within main, side, or off-channel habitats. [3]
	Alcove	An off-channel habitat that is laterally displaced from the general bounds of the active channel and formed during extreme flow events or by beaver activity; not scoured during typical high flows. Substrate is typically sand and organic matter. Generally not as long as the full channel width. [3]
	Percolation Channel	A slough habitat type that is characterized by groundwater percolation from main and side channel flows. Its upstream surface water connection to the active river channel has been cut off due to an accumulation of sediment and debris at the head of the formerly open channel, yet main river flows continue to provide a groundwater source of flow to the percolation channel. At high or overbank flows, an upstream surface water connection to the active river channel may be present. [4]
	Isolated Pond	A self-contained off-channel waterbody that lacks a surface water connection to the main channel when flow is less than bankfull. Substrate is highly variable. An isolated pond may occur within the off-channel slough habitats or elsewhere in the off-channel portion of the river valley. [2]

[1] Source: Trihey 1982.
[2] *Source*: Schmidt et al. 1984.[3] *Source*: Adapted from Moore et al. 1986.
[4] *Source*: Adapted from Peterson and Reid 1984.
[5] *Source*: Adapted from Washington Department of Ecology (WDOE) *Channel Migration Assessment*.

7.9.10. Figures

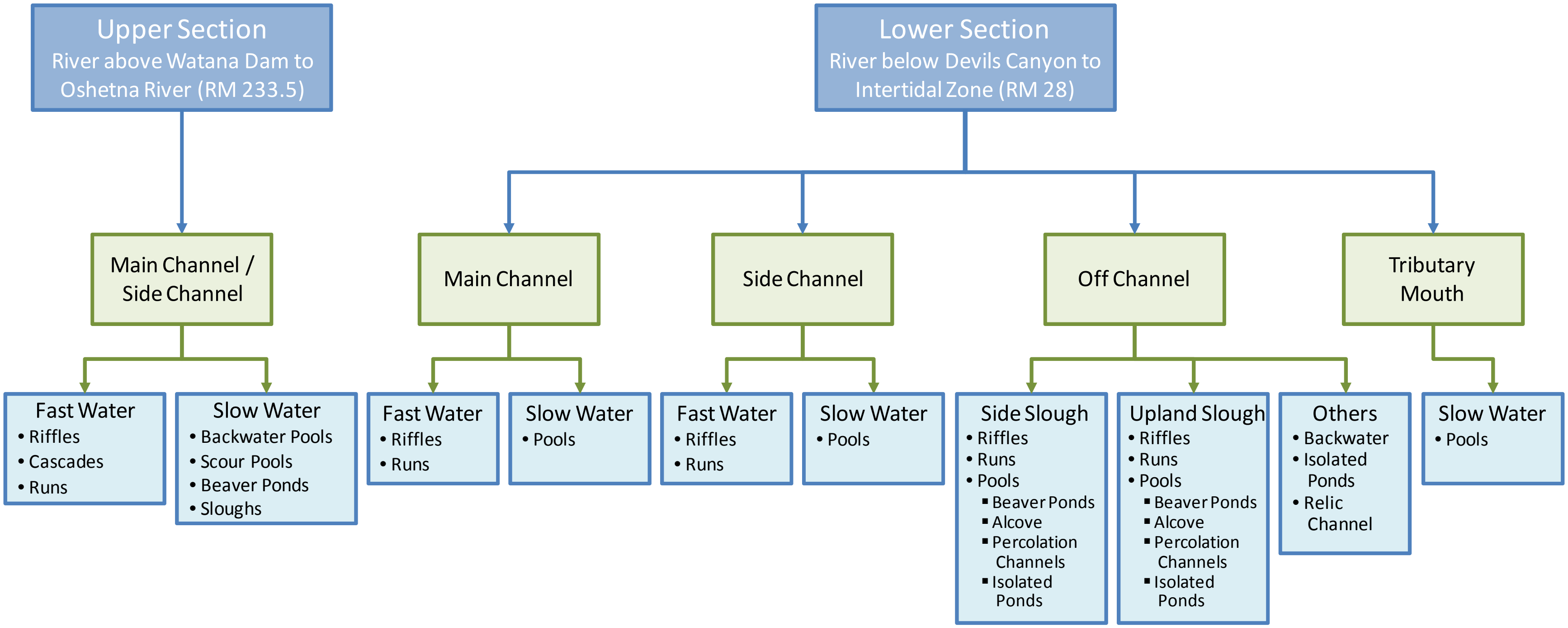


Figure 7.9-1. Hierarchical structure of the Susitna River preliminary habitat classification scheme.

7.10. The Future Watana Reservoir Fish Community and Risk of Entrainment Study

7.10.1. General Description of the Proposed Study

The nature of the fish community inhabiting the proposed Watana Reservoir will depend on a suite of interrelated factors affecting fish populations and their habitat that may be influenced by the design and operation of the Project. This study plan describes the efforts that will be implemented to predict the fish community that will develop in the Project reservoir and identify the effects of the Project on the future reservoir fish community. Figure 7.10-1 shows the relationship between this study and other study programs.

7.10.1.1. Study Goals and Objectives

Construction and operation of the Project will result in inundation of the river upstream from the dam. The actual proposed normal and maximum operating pool levels will depend upon completion of a number of optimization studies, but could be as high as El. 2,100 feet above mean sea level. Several operational scenarios will also be considered as part of the licensing studies. Some operating scenarios, such as load-following, could result in relatively large and frequent fluctuations of the reservoir water surface elevation. Operations would result in seasonal differences in pool elevation such as a winter or early-spring time drawdown in advance of the annual melt of accumulated snow during early summer.

Construction of the Project will fundamentally change the fish habitat characteristics in the area to be inundated. About 39 miles of mainstem river plus several miles of tributary stream will be converted to lacustrine habitat. Conversion from riverine habitat to lacustrine habitat will be beneficial for some fish species and detrimental to others, resulting in a modified fish community. Depending upon the fish protection measures included in the Project license and specific engineering design elements, the modified fish community may be subject to entrainment and mortality as a result of spill or passage through turbines. This study will provide information and tools needed for predicting the likely changes to the fish community due to habitat conversion, potential mortality from entrainment, and for assessing the potential Project operational effects on lacustrine habitat following Project construction.

Understanding the relationship between Project design, operations, lacustrine habitat, and the potential fish community in the proposed Watana Reservoir is important for assessing potential Project impact and development of any necessary PM&E measures. The proposed Watana Reservoir has the potential to provide public benefits in the form of recreational fishing opportunities. Identifying the potential fish community and species valued as sportfish is also important for identifying alternative fishery management strategies in advance of Project construction.

The overarching goal of this study is to predict the fish community that will develop in the Project reservoir based on the existing species and the habitat that will be created in the inundation zone and characterize the potential loss from entrainment. Specific objectives include the following:

1. Develop scenarios for anticipated daily and seasonal changes in reservoir habitat characteristics based on predicted reservoir operations, size, temperatures, and water quality and depth profiles;
2. Develop scenarios for future reservoir fish communities based on current fish species composition upstream of the proposed Dam site and anticipated daily and seasonal changes in reservoir habitat characteristics;
3. Characterize potential management options for the reservoir fishery; and
4. Conduct a qualitative desktop analysis on the potential for entrainment of fish species inhabiting the proposed reservoir upstream of Watana Dam.

7.10.2. Existing Information and Need for Additional Information

Information regarding resident species, non-salmon anadromous species, and the freshwater rearing life stages of anadromous salmon was collected as part of the studies conducted during the early 1980s. Existing information includes the spatial and temporal distribution of fish species and their relative abundance. The Aquatic Resources Data Gap Analysis (ARDGA; AEA 2011a) and PAD (AEA 2011b) summarized this existing information and also identified data gaps for resident and rearing anadromous fish.

At least eight species of fish are known to occur in the upper Susitna River (AEA 2011a). These species are Arctic grayling, Dolly Varden, humpback whitefish (*Coregonus* spp.), round whitefish, burbot, longnose sucker, Chinook salmon, and sculpin (all assumed to be slimy sculpin). Northern pike, Alaska blackfish, and lake trout may also be present. Chinook salmon are the only anadromous species that has been documented in the Upper Susitna River.

In the proposed impoundment zone, Arctic grayling are believed to be the most abundant fish species (AEA 2011a) and were found to spawn in tributary pools. In tributaries, juvenile grayling were found in side channels, side sloughs, and pool margins and in the mainstem at tributary mouths and clear water sloughs during early summer (AEA 2011b). Dolly Varden populations in the Upper Susitna River are apparently small but widely distributed (AEA 2011b). Burbot in the upper Susitna River were documented in mainstem habitats with backwater-eddies and gravel substrate. Longnose suckers were less abundant in the upper Susitna River than downstream of Devils Canyon (RM 150). Lake trout were documented in lakes near the proposed impoundment zone but the impoundment zone has not yet been sampled.

This study is needed to provide information and tools needed for predicting the likely changes to the fish community due to habitat conversion, potential mortality from entrainment, and for assessing the potential Project operational effects on lacustrine habitat following Project construction.

7.10.3. Study Area

The study area encompasses all portions of the basin to be inundated by the proposed Watana Reservoir up to the maximum reservoir water surface elevation to be determined during finalization of design and operational scenarios. About 39 miles of mainstem river (beginning at the dam site at RM 184) plus an unknown amount of tributary stream, will be converted to lacustrine habitat. During normal operation, the reservoir level may fluctuate substantially on a daily and seasonal basis. Annual drawdowns are anticipated to exceed 100 feet with a maximum drawdown of 150 feet. The Project is currently planned to be operated in a load-following mode to maximize firm power generation during winter (November through April), but inflows into the reservoir during this period are anticipated to be relatively low.

7.10.4. Study Methods

The following sections describe the approach that will be used to address each of the four interrelated study objectives associated with the Future Watana Reservoir Fish Community and Risk of Entrainment Study. Each component incorporates significant agency recommendations regarding the general study approach and specific methods to be used. These were developed collaboratively during the drafting of the relevant Study Request. Where appropriate, each study component has been broken down into separate tasks.

7.10.4.1. Reservoir Habitat Scenarios

Based on the alternative Project operating scenarios identified by Project engineers, this study component will develop corresponding scenarios for anticipated daily and seasonal changes in reservoir habitat characteristics. This study component is composed of the three following tasks that will consider reservoir conditions related to the relative size of lacustrine zones, water temperature, and turbidity.

Task 1 – Lacustrine Zone Estimation

Project operations will influence the relative size of different lacustrine zones and, as a result, the amount of habitat for aquatic biota that inhabit each zone. This task will coordinate with the hydrologic study team to adapt an existing model, such as HEC-ResSim, or develop a new unsteady flow hydraulic model of the proposed reservoir that can be used to evaluate daily and seasonal changes in reservoir depth and the amount of exposed shoreline. Based on LiDAR data and a series of transects across the proposed reservoir, model results will provide reservoir water surface elevations and depths that will be used to develop estimates of the size of each of the following lacustrine zones under the alternative operating scenarios identified in coordination with project engineers:

Varial Zone: Area alternately wetted and dewatered by water level fluctuations; can include some or all of the littoral zone.

Littoral Zone: Near-shore area extending to the deepest extent of light penetration sufficient for primary production.

Limnetic Zone: Open-water layer with sufficient light penetration for primary production to occur.

Profundal Zone: Open-water layer too deep for primary production to occur; below the limnetic zone.

Benthic Zone: Bottom layer of the reservoir associated with the substrate and underlying all other zones.

An important part of this task will be the development of assumptions related to reservoir operations to be incorporated into the hydraulic model. These model assumptions will be developed collaboratively with the Fish and Aquatic TWG. Additional assumptions pertain as to how the lacustrine zone is defined temporally and spatially. Temporal aspects of the defined lacustrine zone will consider minimum and maximum time intervals appropriate to the frequency and magnitude of water level fluctuations expected under the alternative operating scenarios, in particular those related to peaking operations. Spatial definitions will consider turbidity or other factors related to light penetration that also may vary at least seasonally.

Task 2 – Water Temperature Modeling

This task will involve the development of a water temperature model of the proposed reservoir that can be used to evaluate daily and seasonal changes in water temperatures and the potential for thermal stratification. The water temperature model will be developed in coordination with the water quality assessment team and as part of the proposed Water Quality Modeling Study. It is anticipated that the Environmental Fluid Dynamics Code (EFDC), or similar model, will be used for this effort. Model results will be used to predict daily and seasonal variations in reservoir temperatures, including temperature profiles, and identify the potential for thermal stratification. This task will summarize the reservoir temperature model results including an assessment of how the results relate to the future reservoir fish community.

Task 3 – Reservoir Turbidity

Turbidity levels can influence the suitability of aquatic habitat for certain fish species. This task will involve reviewing available information to identify turbidity thresholds that can limit reservoir habitat utilization for species that may otherwise overwinter in the Watana Reservoir. The target species for this effort are lake trout, burbot, grayling, and whitefish. Historic information collected in the Susitna basin during the 1980s and synthesized as part of a 2012 study (Synthesis of Exiting Fish Population Data) will be reviewed to identify utilization relative to turbidity levels. Information collected in 2012 as part of the Upper Susitna River Fish Distribution and Habitat Study will also be reviewed as well as turbidity threshold information available for the target species from other out-of-basin literature sources. This information will be compared to turbidity levels expected to occur in the Watana Reservoir that are identified in coordination with the water quality assessment team. Species-specific turbidity exceedances in the Watana Reservoir during winter will be identified to predict the degree, if any, to which turbidity will limit the overwintering use of reservoir habitat by lake trout, burbot, grayling, and whitefish.

7.10.4.2. Reservoir Fish Community Scenarios

Creation of the reservoir and operation of the Project will drastically alter the habitat available to the existing fish community in the inundation zone. The future reservoir fish community will be determined by the altered habitat conditions, as well as the segment of the existing fish community expected to utilize the reservoir. This study component will develop scenarios for future reservoir fish communities based on the current fish species composition upstream of the proposed dam site and anticipated reservoir habitat characteristics. This study component is composed of the following three tasks related to the existing fish community, potential use of the reservoir by these species, and the potential presences of invasive species.

Task 1 – Define Existing Fish Community

Species that comprise the existing fish community in the Susitna River and certain sub-basins represent the source stocks from which the reservoir could be colonized. In this task, information from two studies conducted during 2012, the Synthesis of Exiting Fish Population Data Study and the Upper Susitna River Fish Distribution and Habitat Study, will be reviewed to characterize the existing fish community in the mainstem river and any tributaries or lakes that could colonize the reservoir. Potential colonizing species will be identified based on their presence in the inundation zone, proximity/connectivity to the inundation zone, and the likelihood of potential movements to the inundation zone.

Task 2 – Identify Potential Use of Lacustrine Habitat

Although the reservoir could potentially be colonized by fish species identified in Task 1, future reservoir habitat may not be suitable for all species. This task will involve a literature review to identify species in the existing fish community that may use lacustrine habitat for one or more life history stages. A white paper will be prepared that identifies the life history and habitat requirements for each species, with a focus on lacustrine elements. The discussion for each species will include an assessment of uncertainty in predicting their lacustrine habitat use. This assessment will be written to aid in the development of a post-construction monitoring program by identifying such uncertainties as expected life histories or those related to future reservoir habitat conditions.

Task 3 – Identify Potential Invasive Species

Northern pike are considered an invasive species in the Susitna drainage and have spread throughout the system from the Yenta drainage after being illegally introduced in the 1950s (AEA 2011b). Alaska blackfish are also considered an invasive species and, while not captured in the Susitna River, may have been introduced to the system. This task will identify the presence of invasive species in lakes and ponds that are currently disconnected from the mainstem but have the potential to be inundated. Information from the two 2012 studies identified above will be reviewed to identify water bodies in which invasive species have been found and that have the potential to be inundated.

7.10.4.3. Reservoir Fishery Management Options

This study component will characterize potential management options for a future reservoir fishery. A future fishery in the Watana Reservoir will be dependent upon the habitat conditions and fish community expected to occur in the reservoir, as described by the previous study components. Management options related to a reservoir fishery will be dependent on public access and recreational goals established for the reservoir. As such, analyses associated with this study component will be conducted in 2014 when more information on public access and recreational goals for the reservoir are available. Implementation of this study component will involve collaborating with ADF&G and the Fish and Aquatic TWG in the development of alternative fishery management strategies for the reservoir. This effort will also coordinate with the recreation team to determine the recreational basis and potential access in support of a potential fishery. The technical memorandum for the overall study will include a section in which the potential management options for a future reservoir fishery, developed in collaboration with ADF&G and the Fish and Aquatic TWG and in coordination with the recreation team, are described in detail.

7.10.4.4. Entrainment Analysis

Fish inhabiting the proposed reservoir could be susceptible to entrainment through the Project (turbines or spillways) or impingement on the intake trash racks. This study component will involve conducting a desktop analysis of the potential for entrainment and impingement of fish species inhabiting the proposed Watana Reservoir. This study component is comprised of the following three tasks related to identifying Project design and operating scenarios, reviewing relevant literature related to entrainment at other projects and biological information for target species, and analyzing this information to assess entrainment and impingement risks at the Project. Target species will be drawn from the Reservoir Fish Community Scenarios and identified in collaboration with the Fish and Aquatic TWG.

Task 1 – Identify Project Design/Operating Scenarios

Potential entrainment risks are influenced by Project design and operations. This task will involve coordinating with Project engineers to understand alternative Project designs and operating scenarios. This task is anticipated to be conducted in 2014 when more dam design and operational details are available. Specific design and operational details to be considered that can directly influence entrainment risks include

- Intake approach velocities
- Trash rack spacing
- Intake depths and design
- Outlet depths and design
- Operating head
- Turbine design
- Turbine speed
- Generation
- Spillway design
- Spill height
- Spill frequency

Task 2 – Literature Review

An abundance of information is available in the literature regarding fish entrainment at hydropower projects (i.e., EPRI 1997, Franke et al. 1997, FERC 1995). This task will entail reviewing such information as well as other analyses of entrainment risks with a focus on deep water intakes and cold water reservoirs. Biological information related to the future Watana Reservoir fish community identified as part of this study will also be considered to identify species and lifestages expected to inhabit the reservoir that may be at risk of entrainment or impingement. Additional biological information related to entrainment and impingement risks will be obtained from the literature. Such information includes the swimming ability of target species, which will influence their ability to avoid entrainment as they approach the intakes, as well as fish size (i.e., body length and width) which will influence impingement risks. General behavioral information related to movements in the water column and reservoir habitat use will also be reviewed.

Task 3 – Desktop Analysis

This task will involve synthesizing the information collected in the previous tasks to conduct a desktop analysis identifying the potential vulnerability target species in the anticipated reservoir community to entrainment and impingement mortality at the proposed dam under alternative design and operating scenarios. Because the size and composition of fish populations comprising the future reservoir community is theoretical under pre-Project conditions, rates of entrainment or impingement will not be predicted as part of this task. Rather, this analysis will focus on identifying species and lifestages at risk of entrainment or impingement based on their size, swimming ability, periodicity, and/or behavior. The analysis will also identify the relative risks associated with different potential sources of indirect or direct mortality, including impingement, strike, shear, grinding, turbulence, cavitation, pressure changes, and dissolved gas levels.

7.10.4.5. Work Products

Deliverable work products include the following:

Summary of Interim Results

Interim reports will be prepared and presented to the Fish and Aquatic TWG to provide study progress. Reports will include up-to-date compilation and analysis of the data and ArcGIS spatial data products.

ArcGIS Spatial Products

Shape files of the various lacustrine zones will be created for each alternative operating scenario. 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 ADNR standards. Naming conventions of files and data fields, spatial resolution, and metadata descriptions must meet the ADNR standards established for the Susitna-Watana Hydroelectric Project.

Study Reports

An Initial and Updated Study Report that summarizes study progress and results gathered to date will be prepared and presented to resource agency personnel and other licensing participants, along with spatial data products.

7.10.5. Consistency with Generally Accepted Scientific Practice

The study methods have been developed in consultation with relicensing participants. The methods chosen to accomplish this effort are consistent with standard techniques used throughout the fisheries scientific community. The use of models is common technique used for assessing potential effects of a proposed project. The proposed modeling frameworks described below were developed by the U.S. Army Corps of Engineers and Environmental Protection Agency specifically for predicting the behavior of reservoirs and simulating physical water resource processes.

7.10.6. Schedule

This is largely a desktop analysis that will be completed in late 2013 and 2014 as information from other studies becomes available. Because the completion of this study is dependent on information from other studies, the schedule for this study will be further refined as the scheduling of related studies are completed. A draft schedule for this study is shown in Table 7.10-1. Results from the Reservoir Habitat study component will inform the Reservoir Fish Community study component. In turn, results from the Reservoir Fish Community study component will inform both the Reservoir Fishery and Entrainment study components. As such, the draft schedule reflects the appropriate ordering of implementation for each study component.

Initial and Updated Study reports documenting actions taken to date will be issued in December 2013 and 2014, respectively.

7.10.7. Level of Effort and Cost

Several components of this study will rely on modeling or other efforts developed in coordination with other study programs. As such, the level of effort and expected cost associated with each study component is dependent upon the distribution of effort among the different study programs. The total estimated cost for this study is $165,000. The estimated costs associated with each study component are provided below and include assumptions related to the distribution of effort. The staffing and costs for this study will be further refined as other related portions of the 2013-2014 study program develop.

Reservoir Habitat Scenarios

The estimated cost to complete this study component is $60,000. This cost assumes that the hydrology study team will perform the majority of the reservoir hydraulic modeling effort and water quality study team will perform the majority of the water temperature modeling effort.

Reservoir Fish Community Scenarios

The estimated cost for this study component is $40,000.

Reservoir Fishery Management Options

The estimated cost for this study component is $25,000. This cost assumes that the recreation study team will develop the recreational basis for a future reservoir fishery.

Entrainment Analysis

The estimated cost for this study component is $40,000.

7.10.8. Literature Cited

AEA (Alaska Energy Authority). 2011a. Aquatic Resources Gap Analysis. Prepared by HDR, Inc., Anchorage. 107 pp.

AEA. 2011b. Pre-application Document: Susitna-Watana Hydroelectric Project FERC Project No. 14241. December 2011. Prepared for the Federal Energy Regulatory Commission, Washington, DC.

EPRI (Electric Power Research Institute). 1997. Turbine survival and entrainment database – field tests. EPRI Report No. TR-108630. Prepared by Alden Research Laboratory, Inc. Holden, MA. 13 pp and two 3.5" diskettes.

FERC (Federal Energy Regulatory Commission). 1995. Preliminary assessment of fish entrainment at hydropower projects – volume 1 (Peper No. DPR-10). Office of Hydropower Licensing, FERC, Washington, DC.

Franke, G.F., D.R. Webb, R.K. Fisher, D. Mathur, P.N. Hopping, P.A. March, M.R. Headrick, I.T. Laczo, Y. Ventikos, F. Sotiropoulus. 1997. Development of environmentally advanced hydropower turbine system design concepts. U.S. Dept. of Energy and Hydropower Research Foundation. July 1997.

7.10.9. Tables

Table 7.10-1. Schedule for implementation of the Future Watana Reservoir Fish Community and Risk of Entrainment Study.

Activity	2012				2013				2014			
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q
Reservoir Habitat Scenarios							---------	------●				
Initial Study Report							---------	------●				
Reservoir Fish Community Scenarios								---------	------●			
Reservoir Fishery Management Options									---------	------●		
Entrainment Analysis									---------	------●		
Updated Study Report									---------	---------	------Δ	----▲

Notes:

- ● Interim results
- Δ Draft version
- ▲ Final version

7.10.10. Figures

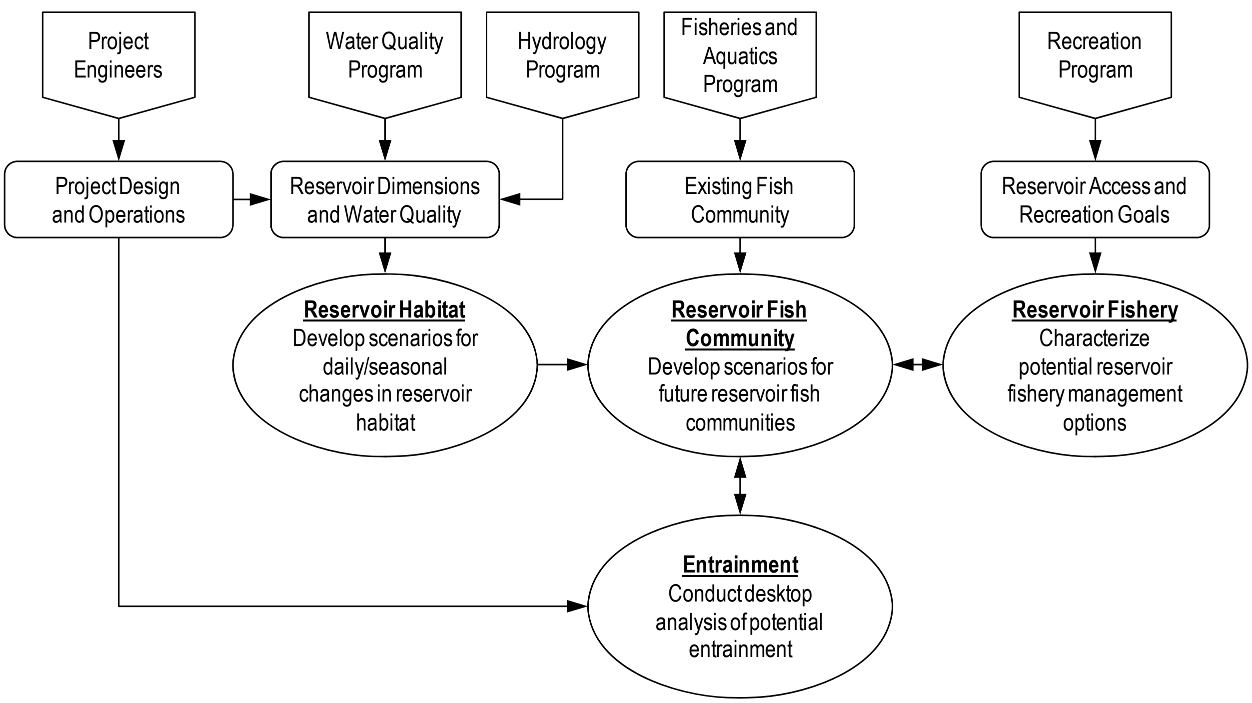


Figure 7.10-1. Flow chart showing relationships between components of the Future Watana Reservoir Fish Community and Risk of Entrainment Study (ovals), other study programs, and related information.

7.11. Study of Fish Passage Feasibility at Watana Dam

7.11.1. General Description of the Proposed Study

The proposed Watana Dam would create a passage barrier on a free-flowing river that supports five species of Pacific Salmon, other anadromous fish species, as well as several migratory resident fish species. Information regarding the biological need for and the engineering feasibility of passage at this location is integral to the resource management decisions that pertain to the license application for construction and operation of the Project as proposed. In implementing this study plan, AEA will compile the available biological information from the 1980s through 2013-14 studies and will develop new information regarding the feasibility of engineering solutions to fish passage at the proposed dam site. AEA will assimilate this information and conduct a conceptual level analysis of engineered passage solutions.

7.11.1.1. Study Goals and Objectives

The primary goal of this study is to determine the biological assumptions and feasibility of developing upstream and downstream passage facilities at Watana Dam. A variety of engineering, biological, sociological, and economic factors may need to be considered. The objective of this study is to compile existing information to support future discussions of potential fish passage measures with licensing participants during the FERC licensing of the Susitna-Watana Hydroelectric Project.

7.11.2. Existing Information and Need for Additional Information

The central feature of the proposed Project is the 700 to 800 foot high Watana Dam at river mile (RM) 184 on the Susitna River that would block the upstream passage of Chinook salmon, possibly other salmon species, and resident fish that migrate through and otherwise use the proposed Watana Dam site and upstream habitat in the Susitna River and tributaries. Chinook salmon were documented in two tributaries to the proposed reservoir during 2003 and 2011 ADF&G sampling efforts. Juvenile Chinook were found in Kosina Creek in 2003 and one adult was observed in 2011 at an approximate elevation of 2,800 feet; juveniles were also found in the Oshetna River near its confluence with the Susitna River, but none were observed in 2011 (ADF&G 2003a and b, 2011). Aside from these observations, other salmon species have been documented above the dam site, but little else is known about anadromous species use above the dam site in either the Susitna River or its tributary streams.

There is currently no specific engineering information and little biological information to provide a basis for determining the need for and feasibility of passage at the proposed Watana Dam. Pacific salmon (all five species) were captured in the lower and middle Susitna River during the 1980s. The extent of their presence in the upper river has not been well documented. Coho, chum, sockeye, and pink salmon were found in the lower and middle Susitna River during the 1980s, but have not been observed upstream of Devils Canyon. ADF&G radio-telemetry studies with sockeye, coho, and chum salmon have been conducted for several years and have not yet documented any tagged fish above Devils Canyon. In 2012, AEA expanded these studies in coordinated with ADF&G to include additional species and add in a focused investigation of distribution of coho, Chinook, sockeye, chum, and pink salmon above Devils Canyon.

Chinook salmon is the one anadromous species known to pass Devils Canyon at relatively low numbers (maximum peak count of 46 adult Chinook salmon during 1984; Thompson et al. 1986). Juvenile Chinook salmon are the only anadromous species known to rear in the upper Susitna River and tributaries (Fog Creek, Kosina Creek, and the Oshetna River) (Buckwalter 2011). Very little is known about Upper Susitna Chinook salmon in terms of run size and inter-annual variability, locations of spawning, rearing, and over-wintering areas, and timing and duration of key life history events (e.g., upriver migration and spawning, period of freshwater residency, smolt out-migration). It is also unclear what flow conditions permit passage through Devils Canyon.

In addition to the anadromous salmon, humpback whitefish and Dolly Varden also express anadromous life history patterns (Morrow 1980), but these life history patterns have not been documented for Susitna River populations. Both of these species have been documented in the Upper Susitna River (Delaney et al. 1981a). In 2012 otoliths will be collected in order to evaluate the presence of anadromy for Susitna populations of Dolly Varden and humpback whitefish. Pacific lamprey exhibit an anadromous life history pattern and have been observed in nearby river systems (Chuit River, Nemeth et al. 2010), but do not have a documented presence in the Susitna River. Other resident fishes present in the Upper Susitna River that may be affected by changes in connectivity between the upper and lower river include Arctic grayling, burbot, round whitefish, a variety of sculpin species, and possibly rainbow trout.

7.11.3. Study Area

The study area extends from the confluence with Portage Creek (RM 148) up to the proposed Watana Dam site (RM 184). It is assumed that any potential upstream passage facilities to be considered (e.g., a trap and haul facility) would be located in the mainstem upstream of the confluence with Portage Creek.

7.11.4. Study Methods

This study will generally follow the guidance provided in NMFS's Anadromous Salmonid Passage Facility Design document (NMFS 2011). Specific study tasks include the following:

- Compile, review, and summarize information;
- Perform site reconnaissance;
- Define and document a development process;
- Develop conceptual alternatives;
- Refine and Evaluate Conceptual Alternatives; and
- Conduct passage feasibility analysis.

Agency coordination and consultation is an integral component of this study. As such, AEA will identify a Fish Passage Workgroup with representatives from state and federal agencies, FERC, and other interested licensing participants. This Workgroup will be convened at regular intervals throughout the study to assist with process development, brainstorming of conceptual ideas, development of evaluation criteria, and design of components. Meetings to accomplish this coordination are expected to occur in all but the initial task listed above.

7.11.4.1. Compile, Review, and Summarize Information

A concise document will be prepared that compiles existing biological, physical, and Project features information needed for assessing passage feasibility. Existing data will be obtained from the 1980s studies, ADF&G surveys between 2003 and 2011 and data developed during the licensing baseline study program and will include the following elements:

- Biological
    - Target fish species
    - Life history periodicity
    - Life-stage specific size, behavior, swimming capacity, and other physical passage constraints
    - Abundance and distribution upstream (including specific spawning locations) and downstream of the proposed Watana Dam site
    - Identify any predatory and/or invasive species that are present and how they might be affected by the Project or any passage facilities
    - Genetics information
- Physical
    - Topographic survey
    - Water quality
    - Hydrologic and hydraulic information
- Project Features
    - Project conceptual drawings
    - Project operations
    - Aerial photos
    - Seasonal flows downstream of the Project (e.g., tailwater rating curve)
    - Seasonal pool elevation (e.g., forebay rating curves, fluctuations, etc.)
    - Project design components (e.g., turbine type, draft tube velocity, sediment capacity, etc.)

Much of the information identified above is being developed as part of 2012 and 2013-14 studies, such as Fish Distribution and Abundance and Salmon Escapement studies. This task will be coordinated with these studies to maintain consistency and to minimize duplication of effort. Additional information may be collected as necessary during the passage feasibility portion of the study.

7.11.4.2. Site Reconnaissance

AEA will organize a site reconnaissance to be attended by members of the Fish Passage Workgroup. At a minimum, the reconnaissance will consist of a helicopter fly-over of the study area from the mouth of Portage Creek to the proposed Watana Dam site at RM 184, as well as tributaries to the reservoir where Chinook salmon are have been documented (i.e. Kosina Creek and Oshetna River). If weather and river conditions allow, the team will land and reconnoiter from the ground at selected locations and discuss potential passage solutions.

7.11.4.3. Define and Document a Development Process

The methods and criteria for determining biological assumptions and feasibility will be developed cooperatively between AEA in consultation with interested licensing participants. At a fundamental level, the biological goals and objectives drive the process, while the technical issues and costs constrain the potential solutions for meeting these goals and objectives. Evaluation criteria will include, but not be limited to

- Biological goals, objectives, and concerns (i.e., target species, swimming capability, life stage, and periodicity);
- Project design and operational constraints;
- Technical issues (i.e., constructability, compatibility with project design and construction schedules, ease of modification, ease of monitoring, etc.); and
- Facility costs (i.e., estimates of costs associated with the construction of capital facilities, lost generation, and operation and maintenance needs).

AEA will propose a draft development process and host a workshop to discuss and refine the process as well as establish appropriate evaluation criteria. Documentation will include an evaluation matrix (i.e., a Pugh comparison matrix) that includes applicable design criterion and weighting factors for each criterion. A final technical memorandum will be prepared that describes the development process.

7.11.4.4. Development of Conceptual Alternatives

This task includes the formation of a Fish Passage Workgroup that will develop a range of conceptual alternatives, including cost estimates, for upstream and downstream passage solutions. The alternatives must be compatible within an ice-affected climate and must meet existing regulatory requirements.

7.11.4.5. Refinement and Evaluation of Conceptual Alternatives

This task includes the synthesis of the biological, hydrological, and geological data with engineering design alternative and socioeconomics to determine the feasibility of passage at the proposed Watana Dam site. Conceptual alternatives that are determined to not be feasible will be eliminated from further consideration. The evaluation criteria that were developed collaboratively by the Fish Passage Workgroup would be used to evaluate the relative merits of the remaining alternatives. Refinement of the conceptual alternatives will include preparation of feasibility-level drawings that would be integrated into the feasibility level engineering design of the project to help communicate the design concepts.

7.11.5. Consistency with Generally Accepted Scientific Practices

The study approach generally follows steps outlined in federal guidelines for Anadromous Fish Passage Design published by the National Marine Fisheries Service (NMFS 2011).

7.11.6. Schedule

Upstream and downstream fish passage facilities can have a significant effect on the overall design and cost of the Project. Consequently, conceptual alternatives would be completed during

2013 so that further refinement of the top ranked conceptual design(s), if determined to be needed and technically feasible, can continue during 2014. Anticipated milestones are

- Compilation, review, and summary of information – March 2013
- Site reconnaissance – June 2013
- Definition and documentation of a development process – June 2013
- Development of conceptual alternatives – August 2013
- Refinement and Evaluation of Conceptual Alternatives – December 2013
- Completion of an Initial Study Report – December 2013
- Preparation of an Updated Study Report – December 2014

7.11.7. Level of Effort and Cost

This study will not include any fieldwork other than the site reconnaissance. However, significant coordination with agency engineers and biologists is anticipated. In addition, significant engineering design work is anticipated to develop conceptual drawings. The anticipated cost for completing this study is $500,000.

7.11.8. Literature Cited

Alaska Department of Fish and Game (ADF&G). 2003a. Fish Survey Nomination Fish Distribution Database, Nomination 04-067, Waterway 247-10-10200-2880. Alaska Department of Fish and Game, Anchorage, Alaska.

Alaska Department of Fish and Game (ADF&G). 2003b. Fish Survey Nomination Fish Distribution Database, Nomination 04-066, Waterway 247-10-10200-2810. Alaska Department of Fish and Game, Anchorage, Alaska.

Alaska Department of Fish and Game (ADF&G). 2011. Synopsis of ADF&G's Upper Susitna Drainage Fish Inventory, August 2011.

Barrick, L., B. Kepshire, and G. Cunningham. 1983. Upper Susitna River Salmon Enhancement Study. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation Enhancement and Development. 156 pp.

Buckwalter, J.D. 2011. Synopsis of ADF&G's Upper Susitna Drainage Fish Inventory, August 2011. Alaska Department of Fish and Game, Division of Sport Fish, Anchorage, Alaska. 27 pp.

Delaney, K., D. Crawford, L. Dugan, S. Hale, K Kuntz, B. Marshall, J. Mauney, J. Quinn, K. Roth, P Suchanek, R. Sundet, and M. Stratton. 1981a. Resident Fish Investigation on the Upper Susitna River. Alaska Department of Fish and Game, Anchorage, AK. 157 pp.

Morrow, J.E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Co., Anchorage.

Nemeth, M.J., A.M. Baker, B.C. Williams, S.W. Raborn, J. T. Preist, and S.T. Crawford. 2010. Movement and abundance of freshwater fish in the Chuit River, Alaska, May through July 2009. Annual Report, Anchorage, Alaska.

NMFS (National Marine Fisheries Service). 2011. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon.

Thompson, F. M., S. Wick, and B. Stratton. 1986. Adult Salmon Investigations: May - October 1985. Alaska Department of Fish and Game, Susitna Hydro Aquatic Studies, Anchorage, Alaska. 173 pp.

7.12. Study of Fish Passage Barriers in the Middle and Upper Susitna River and Susitna Tributaries

7.12.1. General Description of the Proposed Study

Construction and operation of the Project will likely affect flow, surface water elevation, sediment load and transport, and water depth, in the mainstem channel of the Susitna River at tributary confluences as well as at the inlets and outlets to side channels, sloughs, and various off-channel habitat features both in the area of the inundation upstream from the Watana Dam site and downstream in the potential zone of Project hydrologic influence. These changes in mainstem flow, water elevations and sediment transport can potentially inhibit fish passage into, within, and out of aquatic habitats. Understanding existing conditions of barriers, how those conditions change over a range of stream flows, and the relative importance of habitats upstream of barriers will provide baseline information needed for predicting the likely extent and nature of potential changes to barriers resulting from flow and water elevation changes that will occur due to Project operations.

Environmental variables affecting fish passage in streams are dynamic; therefore, results of this study must be considered representative of only a "snapshot-in-time". The height and configuration of cascades and waterfalls change from season to season with the rise and fall of stream flow, and the feature itself can be present or absent over time with the natural shifting or displacement of keystone rocks or logs. The dynamic alluvial river bed of the mainstem Susitna River also changes with variable flows over time. Thus the bed elevations into and within sloughs, side channels, and at the mouths of tributaries can change within a year, or perhaps not for a decade, or longer. These shifts in bed elevation may change the passage depth conditions, sometimes eliminating and sometimes creating the opportunity for fish passage where it may or may not have previously existed.

Deltas formed at the mouths of tributaries also change in size, height, and composition over time, possibly affecting fish passage into and out of the tributaries. The dynamics of tributary delta formation are primarily a function of tributary sediment load and the erosive power of the mainstem at the tributary mouth. Long-term changes in land use in the tributary watershed, such as increased timber harvest or road building, and changes in the timing and volume of mainstem flow will change tributary mouth passage conditions over time.

This study plan describes a coordinated effort that will be undertaken to identify and evaluate the effects of potential Project-induced changes in water depth and stream bed elevation on fish passage over barriers. Several other fish and aquatic resource studies to be conducted in 2012 and 2013-2014 will be integrated with this passage study to address future Project effects related to flow and sediment transport. This study will describe existing barriers, identify barriers that may be eliminated or created by the Project operation, and will identify potential impacts to fish associated with these anticipated changes. The results will be used to determine what, if any, protection, mitigation, and enhancement measures may be appropriate.

7.12.1.1 Study Goals and Objectives

The goal of this study is to evaluate the potential effects of Project-induced changes in flow and water surface elevation on free access of fish into, within, and out of suitable habitats in the

Upper Susitna River (inundation zone above the Watana Dam site) and the Middle Susitna River (Watana Dam site to the confluence of Chulitna and Talkeetna rivers). This goal will be achieved by meeting the following objectives:

10. Locate and categorize all existing fish passage barriers (e.g., cascade, beaver dam) located in selected tributaries in the middle and upper Susitna River (middle river tributaries to be determined during study refinement);
11. Identify the type (permanent, temporary, seasonal, partial) and characterize the physical nature of any existing fish barriers located within the Project hydrologic zone of influence;
12. Evaluate the potential changes to existing fish barriers located within the Project hydrologic zone of influence; and
13. Evaluate the potential creation of fish passage barriers within existing habitats (tributaries, sloughs, side channels, off-channel habitats) related to future flow conditions, water surface elevations, and sediment transport.

These objectives will be met through the use of existing information, consulting with the Fish and Aquatic TWG and other licensing participants, and the methods described in this study plan.

7.12.2 Existing Information and Need for Additional Information Historic Information

Historic information on anadromous fish passage in sloughs and side channels was collected in the 1980s (ADF&G 1984a). These efforts focused on collection of multi-disciplinary data at specific sloughs and side channels (Table 7.12-1).

Table 7.12-1. Co-location of 1984 aquatic studies pertinent to fish passage at sloughs and side channels.

Slough or Side Channel Name	River mile[1]	Study Name				
		Salmon Passage[2]	Stage/Q[3]	Channel Geometry[4]	Instream Flow[5]	Adult Salmon Use[6]
Whiskers Creek Slough	101.2	X	X	X		X
Mainstem 2 Side Channel	114.5	X	X	X		X
Slough 8A	125.3	X	X	X	X	X
Slough 9	128.3	X	X	X	X	X
Slough 9A	133.2	X		X		X
Side Channel 10	133.8	X	X	X	X	X
Slough 11	135.3	X	X	X		X
Lower Side Channel 11	136.1				X	X
Upper Side Channel 11	136.2	X	X	X	X	X
Slough 20	140.1	X	X	X		X
Side Channel 21	140.6	X	X	X	X	X
Slough 21	141.8	X	X	X	X	X

Slough or Side Channel Name	River mile[1]	Study Name				
		Salmon Passage[2]	Stage/Q[3]	Channel Geometry[4]	Instream Flow[5]	Adult Salmon Use[6]
Slough 22	144.2	X	X	X		X

Notes:

1. River mile is determined from the most downstream point of the study site
2. ADF&G 1984b
3. ADF&G 1984c
4. ADF&G 1984d
5. ADF&G 1984e
6. ADF&G 1984f

Studies conducted in the 1980s by ADF&G evaluated passage in side channels and sloughs for six fish species, including chum, Chinook, sockeye, coho, and pink salmon, and Dolly Varden. Chum salmon were used as a surrogate for the other five species. These studies did not address access changes at existing barriers or access into tributaries.

7.12.2.1 Current Information

Current information specific to the Susitna River includes aquatic studies being conducted by AEA for Project licensing. Project licensing studies that will support the Fish Passage Barriers Study are described below.

- *2012 Aquatic Habitat and Geomorphic Mapping of the Middle River using Aerial Photography (Geomorphic Mapping Study)* - This study will provide a comparison of the habitat mapping conducted in the 1980s with habitat mapping developed at similar discharges in 2012. One of the intents of the Geomorphic Mapping Study is to help address the potential effect of Project operations on the stability of tributary mouths and access to tributaries within the Middle River. It is also intended to provide baseline information to help determine the influence of Project-induced changes on mainstem water surface elevations in July through September on adult salmon access to upland sloughs, side sloughs, and side channels. The Geomorphology Study will coordinate with the Fish Passage Barriers Study and other related studies to identify representative study sites for riverine habitat feature digitizing. Aerial photography at the various flows will help inform the selection, characterization, and demarcation of fish barrier study sites and help identify breaching flows and the backwater influence on fish passage at the selected passage study sites.
- *2012 River Flow Routing Model Data Collection (Flow Routing Study)* - Results of the Flow Routing Study will be used as input for the Passage Study and other related studies as needed to simulate various physical and biological processes. Approximately 100 cross sections will be surveyed in the lower, middle, and upper river sections of the Susitna River. The close proximity of the proposed flow routing transect locations to the previous passage study sites (Table 7.12-2) will greatly assist field data collection and will inform the assessment of the stability of passage conditions over time. Results of Flow Routing Studies in 2013-2014 will also be used as appropriate.

Table 7.12-2. Location of proposed 2012-13 flow routing transect relative to locations of 1984 slough and side channel study sites.

1980's Slough or Side Channel Name	River mile[1]	Salmon Passage Study	River mile[1] Location of Proposed 2012-13 Flow Routing Study Transect
Whiskers Creek Slough	101.2	Yes	101.52
Mainstem 2 Side Channel	114.5	Yes	114.0
Slough 8A	125.3	Yes	124.41/126.11
Slough 9	128.3	Yes	128.66
Slough 9A	133.2	Yes	133.33
Side Channel 10	133.8	Yes	133.3/134.28
Slough 11	135.3	Yes	135.36
Lower Side Channel 11	136.1		136.4
Upper Side Channel 11	136.2	Yes	136.4
Slough 20	140.1	Yes	140.15
Side Channel 21	140.6	Yes	140.83
Slough 21	141.8	Yes	141.49/142.13
Slough 22	144.2	Yes	143.18/144.83

Notes:

1 River miles –based on 1984 river mile index.

- *2012 Upper Susitna River Fish Distribution and Habitat Study* - One component of the Upper River Fish Distribution Study is the identification and characterization of potential fish barriers in tributaries between Devils Canyon and the Oshetna River. The first upstream salmon fish passage barrier encountered in tributaries below approximately 3,000 feet elevation, the highest elevation at which Chinook salmon have been documented, will be located, described, photographed, and measured. Results of the Upper River Fish Distribution Study conducted in 2013-2014 will also be used to evaluate fish use of reaches with barriers.
- *Draft 2013 -2014 Susitna-Watana Instream Flow Study* (IFS) - The IFS plan is focused on development of macrohabitat specific models that can reliably estimate flow-habitat response patterns for different species and life stages of fish and other aquatic biota. In addition, this study will model the effects of flow on passage conditions into and out of specific mainstem habitats. Results of the IFS model will be integrally linked to the barrier analysis to provide complete coverage of existing and potential future depth barriers as well as to synthesize the relevance of passage condition changes to fish populations in the middle and lower Susitna River.
- *2013-2014 Geomorphology Study and Fluvial Geomorphology Modeling below Watana Dam* - The results of these studies, in particular the outputs from the two-dimensional

model at intensive study sites will be used to predict the potential for alteration of channel morphology that may result in creation of fish passage barriers. To address both physical and flow-related barriers, these will be coordinated with the ISF model as well. The fish barrier study will synthesize the relevance of geomorphic passage condition changes to fish populations in the middle and lower Susitna River.

7.12.2.2 Need for Additional Information

The need for additional information regarding potential Project effects on fish passage was identified in the PAD (AEA 2011):

> **F2:** Potential effect of fluctuating reservoir surface elevations on fish access and movement between the reservoir and its tributaries and habitats.
>
> **F6:** Potential influence of the proposed Project flow regime and the associated response of tributary mouths on fish movement between the mainstem and tributaries within the Middle River Reach.
>
> **F7:** Influence of Project-induced changes to mainstem water surface elevations July through September on adult salmon access to upland sloughs, side sloughs, and side channels.

7.12.3 Study Area

The study area includes the mainstem and select tributaries in the upper and middle reaches of the Susitna River that would be affected by the construction and operation of the Project. For purposes of this study, the study area has been preliminarily divided into two reaches:

- Upper Reach—Susitna River and select tributaries within this reach up to the 3,000 foot elevation and extending upstream from Watana Dam site (RM 184) to the upper extent of river influenced by Watana Reservoir up to and including the Oshetna River (see Section 7.5, Figure 7.5-1).
- Middle Reach—Susitna River and select tributaries within this reach, extending from Watana Dam site to the confluence of the Chulitna River (RM 98. Passage studies in the mainstem Middle Reach will include sloughs, upland sloughs, side channels, and tributary mouths and deltas.

Passage studies in tributaries to the Middle Reach will include select tributaries and will extend from the mouth to the upper extent of Project hydrologic influence. The upper limit of hydrologic influence will be determined from supporting studies including the Flow Routing Study and the Geomorphic Mapping Study, among others.

7.12.4 Study Methods

Study methods will vary primarily depending on the type of barrier being assessed. In this study, depth barriers are more of a concern in sloughs, side channels, and mouths of tributaries. Physical barriers (cascades and waterfalls) are more of a concern within tributaries. Beaver dam barriers can occur in sloughs, side channels, and tributaries. While the specific methods for each barrier type differ, the general study components and steps are similar for locating and assessing the various types of barriers.

Methods for the study of fish passage barriers will likely consist of the following study components (these components will be refined based on Fish and Aquatic TWG and licensing participants' input):

- Identify fish species to be included in the passage barrier study;
- Define the passage criteria for the identified fish species;
- Select specific study sites and representative study sites;
- Conduct field studies;
- Coordinate with results of IFS and geomorphic models; and
- Evaluate potential effects of altered fluvial processes on fish passage in sloughs, upland sloughs, side channels, and at tributary mouths.

7.12.4.1 Identify Fish Species

The fish community of the Susitna River includes approximately 18 documented fish species. Within this community some fish species exhibit life history patterns that rely on multiple habitats during freshwater rearing and are thus more sensitive to changes in access to side channels, sloughs, and/or tributary habitats (Table 7.12-3). We will select a subset of species to target for the fish passage barrier analysis based on passage sensitivity, the known distribution of the species, and the locations of potential barriers. The species list will be refined in consultation with licensing participants.

Table 7.12-3. Fish and potential fish species within the lower, middle, and upper Susitna River, based on sampling during the 1980s.

Common Name	Scientific Name	Life History	Passage Sensitive
Arctic grayling	*Thymallus arcticus*	Fresh water	X
Dolly Varden	*Salvelinus malma*	Fresh water/ Anadromous	X
Humpback whitefish	*Coregonus pidschian*	Fresh water/ Anadromous	X
Round whitefish	*Prosopium cylindraceum*	Fresh water	X
Burbot	*Lota lota*	Fresh water	X
Longnose sucker	*Catostomus catostomus*	Fresh water	X
Sculpin	*Cottid*	Fresh water/ Marine	--
Eulachon	*Thaleichthys pacificus*	Anadromous	--
Bering cisco	*Coregonus laurettae*	Fresh water/Anadromous	X
Threespine stickleback	*Gasterosteus aculeatus*	Anadromous/Fresh water	X
Arctic lamprey	*Lethenteron japonicum*	Anadromous/Fresh water	X
Chinook salmon	*Oncorhynchus tshawytscha*	Anadromous	X
Coho salmon	*Oncorhynchus kisutch*	Anadromous	X

Chum salmon	*Oncorhynchus keta*	Anadromous	X
Pink salmon	*Oncorhynchus gorbuscha*	Anadromous	X
Sockeye salmon	*Oncorhynchus nerka*	Anadromous	X
Rainbow trout	*Oncorhynchus mykiss*	Fresh water	X
Northern pike	*Esox lucius*	Fresh water	X

7.12.4.2 Define the Passage Criteria for the Identified Fish Species

Basic categories of fish passage criteria for use in this study include water depth, water velocity, and fish leaping ability. Depth criteria will establish the minimum water depth and the maximum distance (at the minimum depth) through which a fish can successfully pass. Depth requirements for successful passage increase with an increase in the length of passage. Depth criteria will be used to assess access into and within side channels and sloughs. The ability of fish to enter slough and side channel habitats from the mainstem Susitna River and access spawning or rearing areas within these habitats is primarily a function of water depth and the length of a reach when the water is shallow (ADF&G 1984b). Velocity criteria pertain to the ability of the fish to swim against the flow, which varies with fish length and, similar to depth, with the distance over which the velocity is maintained.

Leaping criteria will be established for the vertical and horizontal distances fish must leap to pass a physical barrier.

7.12.4.2.1 Depth Criteria for Adult Upstream Migration

Existing depth criteria for evaluating fish passage include the transect criteria (Thompson 1972) and the depth/distance criteria (ADF&G 1984b). Thompson (1972) involves establishing cross sectional and water surface elevation transects at one or more locations to represent the shallowest conditions a fish may encounter while moving upstream. Although there is no longitudinal factor measured in this method, one can assume the criterion represents a minimum depth over a relatively short stream distance. With this method, depth criterion for an individual species should be based on literature values and would be determined in consultation with the Fish and Aquatic TWG.

The depth/distance method evaluates fish passage in two dimensions: depth of water and distance of travel required. This method and criteria for select species were developed for the 1980s Susitna River studies to assess passage into and within side channels and sloughs (ADF&G 1984b). One component of the depth/distance method is the development of species-specific fish passage curves that define relationships between passage depth and reach length in different habitats. Parameters that were used in the 1980s to differentiate habitats within channels and side sloughs were channel complexity, substrate, and velocity (ADF&G 1984b).

7.12.4.2.2 Leaping Criteria for Adult Upstream Migration

The ability of a fish to pass a vertical barrier is determined by species- and life stage-specific endogenous factors such as burst speed, swimming form, and leaping capability. Exogenous factors include water depth, stream flow, and barrier geometry. Powers and Orsborn (1985) present a detailed analysis of passage at physical barriers to upstream migration by salmon and trout. Their analysis is based on collecting data on barrier geometry and stream hydrology to define the existing hydraulic conditions within the barrier. The hydraulic conditions are compared to known fish capabilities to determine if fish passage is feasible. Predicting successful passage at flows outside of those at the time the data were collected depends on stage discharge or other flow indicators for the site. Powers and Orsborn (1985) presents criteria for Chinook, coho, sockeye, pink, and chum salmon passage at waterfalls and cascades. Other sources of leaping height criteria are available from Reiser and Peacock (1985) and the USFS (2007). Table 7.12-4 presents the leaping criteria from the three sources.

Table 7.12-4. Pacific salmon leaping height capabilities from three sources.

Species	Leaping Height (in feet)		
	Powers and Orsborn (1984)[1]	Reiser and Peacock (1985)	ADNR (2007)
Chinook	7.5	7.9	11.0
Coho	7.5	7.3	11.0
Sockeye	7.5	6.9	10.0
Pink	3.5	4.0	4.0
Chum	3.5	4.0	4.0

Notes:

1 Assumes a trajectory of 80^0 with a condition factor of 1.0. Maximum leaping height is less at a lower trajectory and lower fish condition factor.

Leaping curves and jumping equations assume that the depth of the pool the fish must leap from is adequate. Stuart (1964) suggests a ratio of 1:1.25 (barrier height/leaping pool depth). Reiser and Peacock (1985) also suggest a ratio of 1:1.25 and a pool depth of at least 2.5 meters (8.2 feet). Aaserude (1984) concluded that for optimum leaping conditions the depth of the leaping pool must be on the order of, or greater than, the length of the fish attempting to pass. Because assessment of the leaping pool is fundamental to determining fish passage, leaping pool depth criteria will be investigated as part of the study. The refinement of leaping criteria for use in this study will be determined in consultation with licensing participants.

7.12.4.2.3 Downstream Passage Criteria

In natural systems, a section of very shallow surface flow or dry stream bed is the most likely type of barrier to downstream fish migration or movement. Although impassable depths can occur in any reach due to large scale erosion of stream banks or subsurface slow, a more common concern is the deposition of large amounts of cobble and gravel at tributary mouths.

Fish requiring adequate flows for downstream passage in the Susitna River include anadromous juvenile and migratory resident species that move between summer rearing and overwintering habitats. Most research on downstream passage is related to passage at physical structures such as hydroelectric projects, irrigation diversions, and culverts. There is minimal information on depth criteria for downstream passage in natural environments. Alaska requires that passage depth be greater than 2.5 times the depth of a fish's caudal fin (ADF&G and ADOT&PF 2001 as cited in FHWA 2011). Other sources (Powers and Orsborn 1985 and Webb 1975) suggest that only full submergence is necessary. Maine Department of Transportation (2008) suggests 1.5 times the body thickness.

The species, lifestage, and respective passage criteria for downstream migrating fish will be determined in collaboration with licensing participants as part of this study.

7.12.4.3 Select Specific Study Sites and Representative Study Sites

Selection of tributaries and tributary mouths for passage study in the Upper River will expand upon the 2012 Upper Susitna River Fish Distribution and Habitat Study.

Upper River 2013-2014 passage studies will supplement the 2012 passage study and include

- Passage studies in any streams or stream segments requiring study that were not completed in 2012;
- Second assessment of barriers identified in 2012 that require confirmation; and
- Passage survey within the projected reservoir drawdown (or varial) zone. Selection of tributaries for varial zone passage study will be based on those streams selected for study in 2012 initial surveys.

In the Middle River, tributaries and their mouths and deltas will be selected for passage study unless any of the following is true (based on existing information; if any are true, the tributary will not be studied for passage):

- A fish barrier does not currently exist under natural low flow conditions within the hydrologic zone of influence;
- The IFS or geomorphology models do not indicate the potential for future changes in channel form, channel geometry, and/or water depth; and
- The tributary does not currently support fish species identified as target species for passage study.

The large number and complexity of sloughs and side channels in the Middle River will prohibit total coverage of these habitats for passage studies. Thus, sub-sampling of these habitats will be necessary. This study will coordinate with the IFS and geomorphology studies to identify a subset of tributary mouths, sloughs, and side channels for intensive study that represent the range of conditions present in the river. These intensively studied habitats will be modeled to evaluate how Project-induced flow and sedimentation may affect fish passage conditions on a local scale.

7.12.4.4 Conduct Field Studies

This study will rely upon data collected as part of IFS and geomorphology studies. However, we anticipate the need to collect additional information at IFS and geomorphology study sites and at additional sites primarily for physical barriers but also possibly for potential depth barriers. The following methods describe field activities to be conducted for this study.

To maximize access to habitats, passage barrier field efforts will be conducted under low flow conditions. Discharge relationships developed from the routing and IFS studies will enable passage to be analyzed under a wide range of flows. Field data collection methods will vary among physical barriers and depth passage barriers.

7.12.4.4.1 Physical Barriers

Physical barriers (geologic and beaver dam barriers) will be assessed by following the methods of Powers and Orsborn (1984). Physical barriers in tributaries and beaver dams in sloughs and side channels will be located by first reviewing existing information including

- Topographic maps;
- Current high resolution aerial imagery including aerial imagery and LiDAR from the Geomorphic Mapping Study and the 2011 Mat-Su LiDAR and Imagery Project;
- Results of the 2012 Upper River Fish Distribution Study;
- Results of the Flow Routing Study coupled with the projected effects of proposed Project operations on the zone of hydraulic influence; and
- Other relevant and available sources.

A field survey team of two will walk up tributaries or stream reaches where barriers may be present or where their presence could not be ruled out by existing information. Each potential barrier (including beaver dams) will be assessed in two phases. If a stream feature is a possible obstacle to the species of concern, the geometry of the obstacle will be surveyed including measurements of barrier height, leap distance, and estimated depth of leaping pool at high and low flow. It will be drawn to scale, photographed, and its location fixed with GPS. If the obstacle is clearly not a barrier, its location and basic dimensions will be noted with no further measurements.

If the surveyors have uncertainty regarding the barrier status of an obstacle, a decision tree analysis (URS and HDR 2010) will be implemented that is consistent with Powers and Orsborn (1984) and modified as necessary for site-specific species and barrier conditions.

The barrier analysis decision tree is a step-wise process for evaluating potential barriers in the field. Quantitative metrics are used at each step in the decision tree to identify the impassability of the potential barrier. Decision tree questions logically break down the barrier into its physical component parts, allowing a systematic, repeatable, and comparable evaluation of each potential barrier. An advantage to sequentially evaluating each component of a barrier is that if the answer to the first decision tree question suggests that a barrier is impassable, the evaluation is terminated and additional questions need not be addressed to determine barrier passability.

Not all beaver dams in sloughs and side channels will be surveyed on the ground. All significant beaver dams will be identifiable in high resolution aerial imagery and will be included on the GIS fish barrier layer and/or the wildlife layer. Beaver dams in sloughs and side channels that are selected as representative passage study sites will be surveyed on the ground. Beaver dams may also be surveyed in high-use salmon spawning areas.

Beaver dams are not typically thought to impede the downstream movement of juvenile fish. In the Black River drainage, Alaska, Brown and Fleener (2001) found that "high flows in the drainage provided multiple opportunities for both juvenile and adult fish to move over beaver dams during the season." In *Beaver Management Guidelines*, Canada Ministry of Environment (2001) states "When water is flowing over the dam, juvenile fish are able to migrate downstream, making use of small rivulets at either end of the dam." Pacific Stream Keepers website on controlling beavers states that "Generally, downstream migrating young salmon are not held back by a beaver dam (Kambietz 2003)."

7.12.4.4.1 Depth Barriers

Several environmental variables may affect fish passage in sloughs and side channels and tributary deltas. In general, at a given passage reach the water conditions (primarily depth) interact with conditions of the channel (length and uniformity, substrate size) to characterize the passage conditions that a particular fish encounters when attempting to migrate into and within a slough, side channel, or tributary delta. The likelihood of a particular fish successfully navigating through a difficult passage reach will depend on the environmental conditions as well as the individual capabilities and condition of the fish.

Depth passage in sloughs, upland sloughs, side channels, and at tributary delta mouths will be assessed following the methods of ADF&G (1984b) that focus on salmon passage in sloughs and side channels. Although salmon passage remains a key concern, the passage methods are generally applicable to other species where depth passage criteria are known or can be developed.

Figure 7.12-1 is a flow chart of the methods used by ADF&G (1984b) for evaluating passage in representative sloughs and side channels.

Where necessary to supplement the data collected under the geomorphology study, similar data collection methods, as described above for sloughs and side channels, will be applied at tributary mouths and deltas. The thalweg profile from the lowest extent of the delta or tributary flow upstream to and slightly beyond the upper extent of the delta, or tributary mouth, will be surveyed at low flows. Cross sections will be surveyed at thalweg breakpoints and tributary discharge will be measured. Stage-discharge relationships in the mainstem will be derived from the closest Flow Routing Study transect. If necessary, the stage-discharge rating will be interpolated between the nearest upstream and downstream Flow Routing Study transects. Substrate along the thalweg and uniformity of channel will be recorded. Mainstem water surface elevation will be measured and the site will be photographed. Once analyzed, these data will enable decision makers to determine the effects of mainstem discharge on fish passage from the mainstem into the selected tributaries.

7.12.4.5 Data Analysis and Report

Fish passage is a mechanistic analysis that compares the physical capabilities and periodicity of a fish species or lifestage with the environmental variables of the barrier. Each barrier is analyzed on a case-by-case basis.

For adult fish passage analyses at physical barriers, the primary factors that must be considered to determine probable passage success are:

- Fish species and respective adult leaping criteria;
- Adult migration timing of fish species;
- Geometry of the physical barrier; and
- Estimate of flow range and hydraulics of the barrier present during adult migration timing.

For passage analyses at depth barriers, the primary factors that must be considered to determine probable passage success are:

- Fish species/lifestage and respective depth/distance criteria;

- Migration timing of fish species/lifestage;
- Longitudinal and cross sectional geometry of the passage reach;
- Mainstem breaching discharge; and
- Mainstem backwater discharge.

The upper extent of tributary use by target species in the Upper River will be determined by the analysis of physical barriers in tributaries. The immediate effects of the proposed Project on depth passage in the Middle River, due to changes in river hydrology and hydraulics, will be analyzed based on the factors listed above. Draft and final study reports will include study goals and objectives, field and analytical methods, results, and conclusions/discussion.

7.12.5 Consistency with Generally Accepted Scientific Practice

The study methods presented above are consistent with the study methods commonly followed in investigations of fish passage. These include but are not limited to ADF&G (1984b, c, and d), Powers and Orsborn (1984), Powers and Orsborn (1985), Reiser and Peacock (1985), Thompson (1972), URS and HDR (2010), and USFS (2001). Methods are specifically adapted from these and other well-known contemporary researchers in the science of fish passage, as cited in this study plan.

7.12.6 Schedule

This is a multi-year study. Baseline data collection of natural fish passage barriers in Susitna River tributaries between Devils Canyon and the Oshetna River was initiated in 2012. It is anticipated that the 2013-2014 study of Fish Passage Barriers in the Middle and Upper Susitna River and Susitna Tributaries will be completed according to the following schedule.

- Data Collection – April-October 2013
- Initial Study Report – December 2013
- Data Collection – April-October 2014
- Updated Study Report – December 2014

7.12.7 Level of Effort and Cost

Estimated cost to complete this work is $500,000.

7.12.8 Literature Cited

Aaserude, R. G. 1984. New concepts in fishway design. M.S. Thesis, Department of Civil and Environmental Engineering, Washington State University.

ADF&G 1984a. Aquatic habitat and instream flow investigations (May–October, 1983). C.C. Estes and D.S. Vincent-Lang, eds. Chapters 1 - 9. Susitna Hydro Aquatic Studies, Alaska Deptartment of Fish and Game, Anchorage, AK. Report 3. Report for Alaska Power Authority.

— 1984b. Susitna Hydro Aquatic Studies, Report No.3: Aquatic habitat and instream flow investigations, May - October 1983 (Review Draft). Chapter 6: An evaluation of passage conditions for adult salmon in sloughs and side channels of the Middle Susitna River. Prepared for Alaska Power Authority, Anchorage, AK.

—. 1984c Susitna Hydro Aquatic Studies, Report No.3: Aquatic habitat and instream flow investigations, May - October 1983. Chapter 1: Stage and discharge investigations. Prepared for Alaska Power Authority, Anchorage, AK.

—. 1984d. Susitna Hydro Aquatic Studies, Report No.3: Aquatic habitat and instream flow investigations, May - October 1983. Chapter 2: Channel geometry investigations of the Susitna River Basin. Prepared for Alaska Power Authority, Anchorage, AK.

—. 1984e. Susitna Hydro Aquatic Studies, Report No.3: Aquatic habitat and instream flow investigations, May - October 1983 (Draft). Part II, Chapter 37: An evaluation of chum and sockeye salmon spawning habitat in sloughs and side channels of the middle Susitna River. Prepared for Alaska Power Authority, Anchorage, AK.

—. 1984f. Susitna Hydro Aquatic Studies Report, No.1: Adult anadromous fish investigations, May-October, 1983. Prepared for Alaska Power Authority, Anchorage, Alaska

—. 1984g. Susitna Hydro Aquatic Studies, Report No.3: Aquatic habitat and instream flow investigations, May - October 1983 (Draft). Part II, Chapter 8: An evaluation of salmon spawning habitat in selected tributary mouth habitats of the middle Susitna River. Prepared for Alaska Power Authority, Anchorage, AK.

Alaska Energy Authority (AEA). 2011. *Pre-application Document: Susitna-Watana Hydroelectric Project FERC Project No. 14241*. December 2011. Prepared for the Federal Energy Regulatory Commission, Washington, DC.

Brown, J. Randy and Craig Fleener, 2001. *Beaver dam influence on fish distribution in lentic and lotic habitats in the Black River drainage, Alaska*.

Federal Highway Administration (FHWA). 2011. *Design for fish passage at roadway-stream crossings: synthesis Report.* http://www.fhwa.dot.gov/engineering/hydraulics/pubs/07033/2.cfm. Accessed on June 6, 2012.

HDR Alaska, Inc. 2011. *Aquatic resources data gap analysis*. Draft. Prepared for Alaska Energy Authority. July 20, 2011.

Hetrick, Nicholas, J and Matthew J. Nemeth. 2003. *Survey of coho salmon runs on the Pacific coast of the Alaska Peninsula and Becharof National Wildlife Refuges, 1994 with estimates of escapement for two small streams in 1995 and 1996.* Annual Fisheries Technical Report Number 63. US Fish and Wildlife Service, King Salmon Fish and Wildlife Office, King Salmon, AK.

Kambietz, J. September 18, 2003. *Controlling Beavers*. The Pacific Streamkeepers Federation. http://www.pskf.ca/publications/beavers.htm. Accessed on June 7, 2012.

Maine Department of Transportation. 2008. Waterway and Wildlife Crossing Policy and Design Guide. 3rd Edition, July 2008.

Ministry of Environment, Lands and Parks, Vancouver Island Region. 2001. *Beaver Management Guidelines, Draft, Version 1*. British Columbia, Canada

Powers P. and John Orsborn. 1984. Analysis of barriers to upstream fish migration: An investigation of the physical and biological conditions affecting fish passage success at culverts and waterfalls. Albrook Hydraulic Laboratory, Department of Civil and Environmental Engineering, Washington State University. Project No. 82-14.

Powers, P. D., and J. F. Orsborn. 1985. Analysis of barriers to upstream fish migration, an investigation of the physical and biological conditions affecting fish passage success at culverts and waterfalls. Washington State University, Department of Civil Engineering, Albroook Hydraulics Lab, Pullman, WA.

Reiser, D. W. and R. Peacock. 1985. A technique for assessing upstream fish passage problems at small-scale hydropower developments. Pages 423–432 in F. Olson, R. White, and R. Hamre, editors. *Proceedings of the symposium on small hydropower and fisheries.* American Fisheries Society, Bethesda, Maryland.

Stuart, T. A. 1964. *The leaping behavior of salmon and trout at falls and obstructions*. Department of Agriculture and Fisheries for Scotland, Edinburgh.

Thompson, K. 1972. Determining stream flows for fish life. Presentation at the Pacific Northwest River Basin Commission Instream Flow Requirements Workshop, March 15-16, 1972.

URS and HDR. 2010. Assessment of fish migration at natural barriers in the upper Alameda Creek sub-watershed. A technical memorandum prepared for San Francisco Public Utilities Commission.

U.S. Forest Service. 2001. *Aquatic habitat management handbook*. U.S. Forest Service, R-10 FSH 2090.21.\, Juneau, Alaska.

Webb, P. W., 1975. "Hydrodynamics and Energetics of Fish Propulsion Bulletin 190." Ottawa, Ontario.

7.12.9 Figures

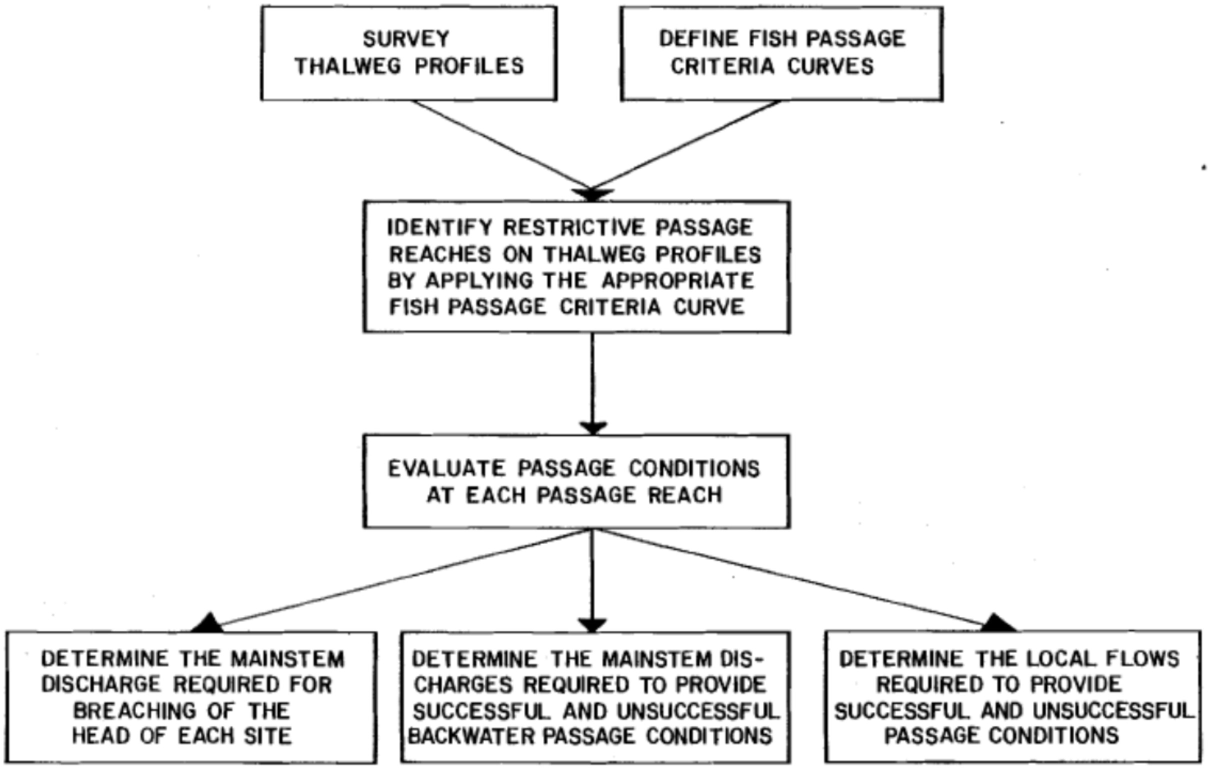


Figure 7.12-1. ADF&G (1984b) flow chart for slough and side channel assessment methods.

7.13. Aquatic Resources Study within the Access Alignment, Transmission Alignment, and Construction Area

7.13.1. General Description of the Proposed Study

Construction and operation of facilities associated with the proposed Project will require both temporary and permanent infrastructure including road, railroad siding, airstrip, transmission lines, and construction camps and staging areas (ADOT&PF 2012). Construction and operation of the Project could affect aquatic habitat where Project access roads, transmission lines, airports, and construction areas cross or encroach on streams and other water bodies.[19] A baseline description of aquatic habitats and fish species present in the vicinity of Project-related infrastructure is needed to provide a basis for assessing potential Project effects and to assist in developing plans for PM&Es, including resource management and monitoring plans.

7.13.1.1. Study Goals and Objectives

The goals of this study are to: 1) characterize baseline condition of the aquatic habitat and fish species composition in the vicinity of the proposed Project's infrastructure including access roads, transmission lines, airports, construction areas, and operation facilities; 2) evaluate the potential for the proposed Project's infrastructure to affect these resources; 3) provide data for determining the least environmentally damaging alternative for purposes of USACE issuance of a dredge and fill permit under Section 404(c) of the Clean Water Act; and 4) to provide data for developing any necessary protection, mitigation and enhancement measures, which may include resource management and monitoring plans.

Specific study objectives are to:

1. Characterize the aquatic habitats and fish assemblages at potential stream crossings within a 200-meter (650-foot) buffer zone along proposed access road and transmission line alignments; and
2. Describe aquatic habitats and species present within the construction area for the dam and related hydropower facilities.

7.13.2. Existing Information and Need for Additional Information

AEA will evaluate up to three possible access alternatives for road and transmission lines. The Denali Corridor would run north from the Watana Dam site and connect to the Denali Highway by road (Figure 7.13-1). Within this corridor, the transmission lines would generally parallel the road to the Denali Highway and would run west along the existing Denali Highway to connect to the Anchorage–Fairbanks Intertie. The Chulitna Corridor would accommodate east-west running transmission lines and a road along the north side of the Susitna River that would connect to the Anchorage–Fairbanks Intertie and the Alaska Railroad near the Chulitna station. The Gold Creek Corridor would also accommodate an east-west access and transmission corridor but would run along the south side of the Susitna River (Figure 7.13-1).

[19] Streams would be crossed using standard Alaska ADOT&PF bridge design, or using culverts as appropriate. AEA anticipates that construction would be completed using standard methods and would rely on local borrow pits/quarries within the corridor for fill and surfacing (AEA 2011).

Construction and operation of the Project facilities will require both temporary and permanent infrastructure including road, railroad siding, airstrip, transmission lines, and construction camps and staging areas (ADOT&PF 2012). Construction and operation of the Project could affect aquatic habitat where Project access roads, transmission lines, airports, and construction areas cross or encroach on streams and other water bodies.[20]

Fisheries and aquatic habitat work specific to each of the proposed transportation access and transmission line alignments has not been conducted since the 1980s. This is ample time for shifts in fish species distribution such as range expansion. Thus a description of current aquatic habitats and fish species in the vicinity of Project-related infrastructure is needed to inform Project design, impact assessment, and development of potential PM&Es as necessary.

The most comprehensive fish and aquatic habitat dataset relevant to this study was generated during the 1980s. In 1983, ADF&G established study sites to characterize aquatic habitat and document fish species presence at 42 stream crossings within the then-proposed access and transmission corridors. Study sites were established at 22 stream crossing sites from the Denali Highway to the Watana Dam site, 14 sites along the Devil Canyon access corridor, and six sites along the then-proposed Gold Creek rail portion of the corridor (Schmidt et al. 1984). The 22 crossing sites along the then-proposed Denali-North (Seattle Creek) alignment correspond reasonably well to the present-day Denali Corridor crossing sites. The 14 study sites along the then-proposed Devil Canyon access, which extended from corridor mile 38 of the old Denali corridor to Devils Creek dam site to the old Gold Creek intertie, relate fairly well to a portion of the present-day Chulitna Corridor. The 6 sites along the old Gold Creek intertie correspond to some of the crossings associated with the western portion of the present day Gold Creek Corridor.

In addition to the *Access and Transmission Corridor Aquatic Investigations* (July—October 1983) report (Schmidt et al. 1984), relevant existing information sources include fish species presence and aquatic habitat data collected and maintained under the *Alaska Freshwater Fish Inventory* (AFFI) program (e.g., Buckwalter 2011) and anadromous fish presence data maintained by the ADF&G *Anadromous Waters Catalog* (*AWC*; ADF&G 2011). The Aquatic Resources Data Gap Analysis (ARDGA; HDR 2011) and AEA's Pre-Application Document (PAD) (AEA 2011) summarized existing information and identified data gaps for aquatic conditions and fish species.

The Alaska Department of Transportation and Public Facilities (ADOT&PF) recently conducted a transportation access study to evaluate access corridors to the Watana Dam site (ADOT&PF 2012). In 2011, the ADOT&PF study team used a helicopter to fly over each access route and identified each stream crossing (those previously mapped and those that did not appear on the USGS map; ADOT&PF 2012). The ADOT&PF team landed at selected stream crossings and estimated channel width and incision depth, and where possible, identified more efficient crossing locations (ADOT&PF 2012). Based on the 2011 field reconnaissance coupled with review of existing aquatic resource data, the ADOT&PF identified the number of stream crossings that would be necessary under each alternative. The ADOT&PF considered the

[20] Streams would be crossed using standard Alaska ADOT&PF bridge design, or using culverts as appropriate. AEA anticipates that construction would be completed using standard methods and would rely on local borrow pits/quarries within the corridor for fill and surfacing (AEA 2011).

number of stream crossings and associated fish passage requirements as part of the screening criteria evaluation (ADOT&PF 2012).

The access and transmission line corridors for the proposed Project have not been finalized. Historic data on fish species presence and aquatic habitat are available for many of the streams that would be crossed; however an updated characterization study is needed to assess current conditions and ensure fish presence is accounted for in all streams and water bodies within the vicinity of the proposed crossing locations. Additionally, a more comprehensive and systematically-collected aquatic habitat dataset is necessary to characterize baseline conditions prior to potential development.

A brief summary of the existing information for each of the proposed access/transmission line corridors is presented below.

7.13.2.1. Denali Corridor

The current Denali access alignment corridor (referred to by ADOT&PF as the Seattle Creek [North] alignment) would require approximately 15 stream crossings from the Watana Dam site to the Denali Highway (ADOT&PF 2012). The Denali Corridor alignment would cross streams within both the Nenana River and Susitna River watersheds. Seattle Creek and Brushkana Creek are the two major drainages crossed within the Nenana River watershed. The Denali Corridor would require eight crossings of tributaries within the Nenana River basin and two crossings in the Susitna River watershed. Deadman Creek is the major stream crossed within the Susitna River watershed.

In the 1980s, biologists conducted fish presence surveys in the vicinity of 10 of these 15 stream crossing sites and recorded general habitat and water quality conditions (Schmidt et al. 1984). Resident fish species were confirmed to be present in the vicinity of nine proposed crossing locations, three sites with intermittent flow were deemed unsuitable for fish use and were not sampled for fish presence, and one site had no fish present (Schmidt et al. 1984).

Schmidt et al. (1984) documented that Dolly Varden, slimy sculpin, and Arctic grayling were relatively widespread along the Denali Corridor. Sculpin were captured near nine of the proposed crossing locations and Dolly Varden and Arctic grayling near six of the proposed crossings. No anadromous fish habitat was documented during these surveys. These streams will be re-surveyed in 2013 along with a subset of streams that would be crossed by the transmission line along the Denali Highway.

7.13.2.2. Chulitna Corridor

The current Chulitna alignment corridor (referred to by ADOT&PF as the Hurricane [West] alignment) would require approximately 36 stream crossings. All streams and water bodies that would be intersected by this corridor drain into the Susitna River watershed. The majority of streams that would be crossed by this alignment are smaller tributary streams. However, this alignment would also cross a number of larger streams, including Pass Creek, the Indian River, and Thoroughfare, Portage, Devil, Tsusena, and Deadman creeks.

The Chulitna corridor alignment would cross several known anadromous fish streams (ADF&G 2011). A crossing of Granite Creek, west of the Parks Highway, would facilitate access to the existing railroad line. The ADF&G *AWC* lists Granite Creek (AWC No. 247-41-10200-2381-

3600) as anadromous fish habitat (ADF&G 2011). Bader and Sinnott (1989) captured juvenile Chinook and coho salmon at a point downstream of the proposed Granite Creek crossing (ADF&G 2011; Bader and Sinnott 1989), and no passage barriers have been identified in that creek between the fish capture site and the proposed crossing.

Pass Creek, located southwest of the Chulitna route crossing, is specified as an anadromous fish stream in the *AWC* (AWC No. 247-41-10200-2381-3236) and is designated to provide habitat for all five species of Pacific salmon (ADF&G 2011). However, a waterfall located downstream of the Chulitna alignment crossing presents a barrier to upstream migration of anadromous fish (ADF&G 2011). The Chulitna alignment intersects nine small, unnamed tributaries to Pass Creek; however, only limited electro-fishing assessment data are available and indicate the presence of Dolly Varden and slimy sculpin at the one location sampled (Buckwalter et. al., 2003).

Three additional streams, Indian River (AWC No. 247-41-10200-2551), Thoroughfare Creek (AWC No. 247-41-10200-2582-3201), and Portage Creek (AWC No. 247-41-1020-2585), have been cataloged (ADF&G 2011) as providing habitat for anadromous fish at the potential crossing sites.

The Chulitna alignment would cross 10 small, unnamed tributaries of Portage Creek, the mainstem of Devils Creek and three of its tributaries, seven smaller tributaries to the upper Susitna River (in the Swimming Bear drainages; Schmidt et al. 1984), as well as Tsusena Creek and two of its tributaries. Fish presence sampling has not been conducted in many of these tributary streams, and passage barriers have not been identified. The presence of barriers on some of the Susitna River tributaries above Devils Canyon is being documented as part of the 2012 Upper Susitna River Fish Distribution and Habitat Study.

7.13.2.3. Gold Creek Corridor

The current road and transmission line alignment within the Gold Creek Corridor would require approximately 23 stream crossings (ADOT&PF 2012). All streams and water bodies that would be intersected by this alignment drain into the Susitna River watershed. The major streams that would be crossed include Gold Creek, Fog Creek, and Cheechako Creek. Smaller streams that would be crossed include tributaries to Prairee and Jack Long creeks and a number of unnamed tributaries to the Susitna River.

The Susitna River (including side channels and sloughs), Fog Creek, Cheechako Creek, and Gold are known to provide habitat for anadromous Pacific salmon (ADF&G 2011). Many of the streams that would be crossed are unnamed tributaries of the Susitna River. Fish data are available for a number of streams that would be crossed. However, much of the available fish data were collected downstream from (i.e. not in the direct vicinity of) the proposed crossing sites (ADF&G 1981, 2011; Schmidt et al. 1984). A total of eight of the 23 streams intersected by the southern alignment are known to provide habitat for anadromous fish downstream of the proposed crossing sites (ADF&G 1981, 2011; Schmidt et al. 1984).

7.13.3. Study Area

The access corridor study area includes streams and water bodies within both the Susitna River and Tanana River watersheds (Figure 7.13-1). The Denali alignment would cross streams within both the Nenana River (a tributary of the Tanana River) and Susitna River watersheds. Seattle

Creek and Brushkana Creek are the two major drainages that would be crossed within the Nenana River watershed. Deadman Creek is the major stream that would be crossed within the Susitna River watershed. All streams and water bodies that would be intersected by the Chulitna and Gold Creek alignments drain into the Susitna River watershed.

The study area will include the aquatic habitats (streams and lakes) in the vicinity of both temporary and permanent Project-related infrastructure including access roads, transmission lines, airports, and construction areas. AEA will establish study sites in aquatic habitats within a 200-meter (650-foot) buffer zone along each access alignment corridor, in the vicinity of the potential airport and hydropower facility construction areas. Figure 7.13-1 shows the streams and lakes (based on the most current hydrography layer) within the three access corridors.

The study area will be adjusted as refinements are made to the proposed Project features and specific alignment routes. AEA expects that the initial 2013 sampling effort will occur over a broad area and that collection of more detailed information within refined alignments will be necessary during subsequent sampling efforts in2014.

7.13.4. Study Methods

7.13.4.1. Synthesis of Existing Information

As part of the 2012 study efforts, historic data for aquatic resources sampling reported in Schmidt et al. 1984 (and associated data to the extent possible), the AWC, and AFFI will be incorporated into a geospatial database for the proposed access alignments. AEA will consult with the agencies and will identify gaps in the historic aquatic habitat and fish species presence database to prioritize the initial 2013 sampling efforts and refine the overall field sampling approach. Based on the existing data review, the overall priority for data collection will be: 1) sites not previously surveyed; 2) sites with no previously documented fish presence; 3) sites with fish presence documented downstream of the potential crossing location; and 4) sites with fish presence documented upstream of the potential crossing location. In this study, AEA does not propose to survey for fish presence in streams where the known anadromous fish distribution extends upstream of a proposed crossing location, but aquatic habitat surveys may be conducted in these locations.

At the onset of this study, locations where aquatic habitat and fish species presence data have been previously collected in the vicinity of the proposed access corridors will be identified. AEA will code streams and water bodies by fish presence (e.g., anadromous fish, resident fish, no fish captured or observed) and will identify streams and water bodies for which no data records were found. For areas where no sampling data are available, the team will review connectivity to adjacent streams and water bodies (e.g., where fish/habitat data are available) to aid in field sample planning.

AEA will initiate studies in 2012 to begin the characterization of fish communities, fish distribution, and aquatic habitat throughout the Susitna River. AEA also will begin a study to document the presence of fish passage barriers in the Upper Susitna River, with a focus on streams within the proposed inundation zone. In 2013 and 2014, AEA will expand these efforts to identify the presence of existing fish passage barriers to tributaries downstream of the proposed Watana Dam site. Fish distribution sampling also will begin in the Upper Susitna River in 2012; efforts will be continued as appropriate in 2013 and 2014. Fish species distribution and fish passage data collected during these studies will be incorporated into the Project database; these data will be used to supplement data collection and analysis specific to this study.

7.13.4.2. Field Data Collection

Study sites will be established at proposed crossing sites in streams along the three potential access and transmission corridors and within the vicinity of construction areas and potential airport locations. To account for potential alignment changes or refinements, sampling will occur within a 200-meter (650-foot) buffer along each alignment corridor in 2013. Study sites will also be established on lakes within the proposed access corridors and in the vicinity of construction locations.

Each alignment will be flown to verify that all streams and/or water bodies within 200 meters (650 feet) of the access and transmission corridors and construction areas are included in the field study. The field team will record the location of each area to be sampled with a GPS unit. The field team will also take photographs to document channel conditions during each field data collection effort. The team will sample for fish presence and record aquatic habitat parameters at each study site, as described below.

AEA expects that the initial information collected in 2012 and 2013 will be assessed during the facilities alternatives analysis and will be used to refine Project design. AEA anticipates that the collection of additional site-specific data may be necessary in 2014 to address any newly identified crossing locations and or fill data gaps.

7.13.4.2.1. Aquatic Habitat Data Collection

The field team will record aquatic habitat characteristics in the vicinity of each potential crossing site. At stream crossing locations, AEA will characterize habitat units to the mesohabitat level in accordance with the channel typing and aquatic habitat classification system currently being developed for the Project by the Fish and Aquatic TWG. Habitat characterization will be based on a modified version of the USFS Aquatic Habitat Survey Protocol (2001). Habitat units encountered will be typed, and parameters that describe the current condition of the habitat unit will be measured. If sections of stream contain two or more different habitat units they will be delineated to the meso-habitat 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. A GPS point will be used to identify the upstream boundary of each mesohabitat unit. Maximum depth and pool crest depth will be measured with a stadia rod and recorded in meters. Wetted and bankfull widths will be measured with a laser range finder and recorded in meters. Dominant substrate type will be estimated by visual identification based on USFS (2001) classifications.

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 meter (39 inches) of the LWD must be below the water’s surface at bankfull 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 meter (39 inches) long.

If, at bankfull 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).

The linear distance of stream habitat characterized at the mesohabitat unit level will be a function of wetted channel width (40 times the wetted width up to a maximum of 400 meters [1,300 feet]). AEA is in the process of developing a systematic approach to characterize lake habitats for the Project. In 2013-2014, AEA will utilize the lake habitat classification system to characterize lake habitats that fall within the study area boundaries.

As Project features are refined, additional site-specific data will be recorded along transects in the close vicinity (in accordance with the Habitat Characterization Protocol) of the anticipated crossing location. Data recorded along transects will include but not be limited to channel bed width, wetted channel width, several water depth measurements across each transect, gradient[21], Rosgen channel type (Rosgen 1994), and water quality field parameters. AEA anticipates the need for such parameters to meet permitting requirements (e.g. ADF&G Fish Habitat Title 16 Permit).

Several water quality parameters that impact aquatic life will be measured during the aquatic habitat assessment, including field measurements of surface water temperature, pH, dissolved oxygen (DO), and specific conductivity. Alaska Department of Environmental Conservation (ADEC) standards for the growth and propagation of fish, shellfish, other aquatic life, and wildlife (ADEC water quality standards for aquatic life) will be used to evaluate measured parameters. Water quality sampling will be conducted in coordination with water quality sampling protocols currently being developed for the Project.

7.13.4.2.2. Fish Data Collection

The goal of this task is to characterize fish assemblages in the vicinity of potential stream crossings. Therefore, sampling will not be conducted throughout the entire length of the stream but instead within close proximity to crossing sites (see below). Species richness in stream fish assemblages is related to both environmental conditions within the stream and stream spatial position within the drainage (Grenouillet et al. 2004). In an effort to characterize species composition at each stream crossing, the field team will establish segments of stream habitat to sample for fish presence at each crossing site. Streams will be sampled as described below. As requested by ADF&G during Fish and Aquatic TWG meetings, sampled water body crossings where no fish are found will be sampled again during a different season to adequately assess fish presence.

The field team will use backpack electrofishing gear (Smith-Root LR-24 or similar) as the primary capture method to inventory streams for fish presence. Single-pass electrofishing was selected as the primary fish capture method because it is considered to be the most effective (Barbour et al. 1999, Simon and Sanders 1999, Flotemersch and Blocksom 2005) and widely applied (Hughes et al. 2002) method used in streams and rivers. Electrofishing typically captures more species with less size selectivity than other gear types (Hendricks et al. 1980), electrofishing equipment is relatively compact and portable, and electrofishing is recommended

[21] One study considered stream width and gradient as 2 of the most influential factors that affected species richness among different habitat variables (Grenouillet et al. 2004).

as a standard sampling method for coldwater fishes in streams (Bonar et al. 2009; J. Buckwalter, ADF&G/Habitat Biologist II, personal communication, October 17, 2011).

Electrofishing settings will be determined in the field based on water quality conditions (e.g., conductivity) and professional judgment. Backpack electrofishing will be conducted by trained staff consistent with established protocols and guidelines (e.g. NMFS 2000; Temple and Pearsons 2007; Buckwalter et al. 2010; J. Buckwalter, ADF&G/Habitat Biologist II, personal communication, October 17, 2011). If adult salmonids or aggregations of large (>300 millimeters [11.8 inches]) salmonids are encountered, electrofishing activities in the immediate vicinity will cease, except to capture fish for species identification (Buckwalter et al. 2010). Other fish sampling methods (e.g., fyke nets, minnow traps) will be used when adult anadromous fish are present and when habitat conditions are not suitable for electrofishing.

The length of stream habitat sampled at each crossing site will be directly proportional to the stream channel's wetted width. The linear distance of stream habitat sampled needs to be long enough to provide a true representation of the fish species present but not so long that it becomes more labor intensive than is necessary to meet the study's objectives (Temple and Pearson 2007). In general, large streams require longer sampling sections than smaller streams to assess community structure (Temple and Pearsons 2007). Temple and Pearsons found that a sample reach with a length between 27 and 31 wetted channel widths was the minimum sampling distance required to detect 90 percent of the fish species present (2007). For small streams, such as headwater streams, other studies report minimum sampling distances of 12 to 50 wetted channel widths (Patton et al. 2000), 35 wetted channel widths (Lyons, 1992), and 40 wetted channel widths (Reynolds et al. 2003; Buckwalter et al. 2010). Recent analysis of data collected by single-pass electrofishing using the 40 wetted channel width reach length found that species richness was typically underestimated on intermediate (e.g. drains 200 square kilometers) and mainstem (e.g., drains 1,500 square kilometers) streams in Alaska (as opposed to target headwater (drains 50 square kilometers) streams (J. Buckwalter, ADF&G/Habitat Biologist II, personal communication, October 17, 2011). Based on the above study results and the anticipated channel size for crossing surveys, AEA proposes to survey a stream length of 40 wetted channel widths, up to a maximum of 400 meters (1,300 feet) of stream length.

In addition, the team will use a combination of methods to sample for a variety of fish species and life stages throughout representative lake habitats. Sampling may include the use of multi-mesh gill nets, baited minnow traps, fyke nets, seine nets, and angling gear. The gear used at individual sampling locations will be a function of habitat conditions encountered. Gear type specifications are as follows.

- Gill nets will be situated perpendicular to shore of lakes and fished at varying depths. The team will deploy nets for a minimum of two hours and check nets frequently 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 a boat and/or drysuits to deploy gear in offshore habitats.
- Minnow traps (also known as basket traps) will be baited with commercially processed roe and secured to vegetation or substrate to sample overnight (roughly 24 hours).
- Fyke nets will be used to document fish species presence. Each net will be equipped with attached wings and detachable center leads with floats and weighted line. Alternative fyke net sizes and designs may also be used depending on conditions encountered.

- Beach seines may be used to target fish too small to be captured by traps or species that typically are not susceptible to sampling with 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-millimeter (0.25-inch) mesh. The seine should be adequate to sample slow water habitats but will likely not be suitable in areas with swift current. Beach seine sampling area will be recorded and involve a single pass through the sample area.
- Angling gear will target larger fish in deeper portions of the lakes. A variety of gear will be used.

Captured fish will be held in buckets and/or live wells until the sampling of each segment is complete. Fish will be identified to species and counted. Up to 100 fish of each species collected at each sampling location will be measured to the nearest millimeter to record fork or total length as appropriate. Fish will be released within the sampling location once sampling activities have ceased. Fish disposition (e.g. released, unintended mortality, voucher specimen, injury) will be recorded for each fish handled. Data will be recorded on a standardized datasheet or field computer form.

AEA will obtain a fish resource permit (FRP) from ADF&G prior to initiation of field sampling activities. Sampling activities will be carried out in compliance with FRP stipulations. Any deviations from the approved study plan will be communicated to ADF&G during or immediately following sampling activities.

7.13.4.3. Data Analysis and Reporting

Data generated during this study will provide baseline data related to fish and aquatic habitat in the vicinity of potential water body crossing locations associated with potential transportation access alignments, transmission alignments, and construction areas. AEA will complete a technical report that summarizes methods and results of the aquatic habitat characterization and fish species assemblages in the study area.

Data generated during this study will be incorporated into the Project's geospatially-referenced relational database. Naming conventions of files and data fields, spatial resolution, and metadata descriptions will meet the standards established for the Project. Use of the Project's geospatial database will also allow data specific to each stream crossing to be queried and readily accessible for Project reporting. The database will be designed to create individual reports by crossing location.

Fish capture data will be submitted to ADF&G per FRP requirements. Fish species assemblage (composition and species richness) and distribution will be reported by sampling location and by stream drainage or lake. Catch per unit effort (CPUE) will be determined by dividing the catch (number of fish captured or observed) by the effort (e.g. sample time). To the extent possible, data collected using different methods will be normalized so results can be appropriately compared. CPUE will be determined for each species by location (e.g. stream reach sampled) and gear type. CPUEs will be used to develop an index of relative abundance for each species captured at stream crossing sites.

7.13.5. Consistency with Generally Accepted Scientific Practice

Electrofishing, gill nets, seine nets, minnow traps, angling, and fyke nets are commonly used methods for sampling fish populations (Murphy and Willis 1996; Backiel and Welcomme 1980). Angling using single barbless lures or flies has become a common method for capturing subject fish. These methods described herein have been developed in consultation with the agencies and other licensing participants. All data collection efforts will follow State guidelines and FRP permit stipulations.

7.13.6. Schedule

The preliminary schedule for the Aquatic Resources within the Access Alignments, Transmission Alignments, and Construction Areas study is as follows. AEA will begin this study by reviewing results of the efforts currently underway to compile existing fisheries and aquatic habitat data. AEA anticipates that the historic and more recent existing data on stream crossings will be available in early 2013.

The field team will conduct fish surveys primarily during July and August 2013, 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 August, such as those in lake habitats or those associated with migration periods. Aquatic habitat surveys are typically conducted at low flows. The timing of low-water events is not known for all crossing locations; in general, low water during the open-water season may occur during fall months just prior to freeze up. Aquatic habitat surveys will be conducted concurrent with fish sampling as conditions allow. However, crossing locations may need to be visited more than once. For sites where no fish are encountered on a first survey, a second survey during a different season will be conducted to help confirm fish use of habitat. As discussed in the methods section, additional surveys are anticipated in 2014 to refine the alignments and/or fill in data gaps. The number of 2014 surveys that will be needed cannot be determined until more information is available.

Initial and Updated Study Reports discussing actions to date will be issued in December 2013 and 2014, respectively.

7.13.7. Level of Effort and Cost

This study will require that data be collected over at least two field seasons, primarily to accommodate potential refinements in Project design. AEA anticipates that data will be collected over a broader study area in 2013, for example, within the larger access corridors shown in Figure 7.13-1. As elements of the Project are refined and specific crossing locations are chosen, additional sites may need to be sampled and the collection of more detailed, site-specific information may be necessary at selected crossing sites throughout the study area.

The study will require at least one part-time senior biologist as study lead and additional support staff including multiple field biologists, a GIS team, and administrative staff. The 2013 field effort will require helicopter support for a minimum of two field teams to collect fish and habitat data at potential water body crossings over the span of approximately 30 field days. The remainder of the 2013 study effort would be office-based, with data entry and quality assurance/quality control, analysis, GIS and database queries, and report development. AEA anticipates that the study area within which additional data will need to be collected in 2014 will be refined and therefore reduced. AEA estimates the 2014 field effort will require helicopter support for potentially two field teams for up to 20 days. The remainder of the 2014 would be office-based.

The initial cost estimate for completion of the study objectives for all three access corridors is roughly $600,000 for the 2-year study period. However, costs could be reduced if the number of proposed corridors is reduced and the alignment(s) are refined for year 2014.

7.13.8. Literature Cited

Alaska Department of Fish and Game (ADF&G). 2011. *Catalog of waters important for spawning, rearing or migration of anadromous fishes*. http://gis.sf.ADF&G.state.ak.us/FlexMaps/fishresroucemonitor.html?mode=awc (accessed October 2011).

Alaska Department of Transportation and Public Facilities (ADOT&PF). 2012. *Draft Watana transportation access study, project no. 82002*. Prepared for Alaska Department of Transportation and Public Facilities, Fairbanks, Alaska, by HDR Alaska, Inc., Anchorage, Alaska 99503. June 2012 Draft.

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

Backiel, T. and R. L. Welcomme. 1980. Guidelines for Sampling Fish in Inland Waters. EIFAC 1980 Technical Paper, (33): 176 p.

Bader, D., and R. Sinnott. 1989. *South Central Anadromous waters catalog nomination form for Granite Creek near the Parks Highway*. AWC Stream No. 247-41-10200-2381-3600, Anchorage, Alaska: Alaska Department of Fish and Game.

Barbour, M. T., J. Gerritsen, D. D. Snyder, and J. B. Stribling. 1999. *Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates and fish, 2nd edition*. U. S. Environmental Protection Agency, Office of Water, EPA Report No. 841-B-99-002, Washington, DC.

Bonar, S. A., W. A. Hubert, and D. W. Willis, editors. 2009. *Standard methods for sampling North American freshwater fishes*. American Fisheries Society, Bethesda, Maryland.

Buckwalter, J.D. 2011. *Synopsis of ADF&G's Upper Susitna drainage fish inventory, August 2011*. November 22, 2011. ADF&G Division of Sport Fish, Anchorage, Alaska.

Buckwalter, J.D., J.M. Kirsch, and D.J. Reed. *2010 Fish inventory and anadromous cataloging in the lower Yukon River drainage, 2008* Alaska Department of Fish and Game, Fisheries Data Series No. 10-76 Anchorage.

Flotemersch, J, E., and K. A. Blocksom. 2005. Electrofishing in boatable rivers: does sampling design affect bioassessment metrics? *Environmental Monitoring and Assessment* 102:263-283.

Grenouillet, G, D. Pont, and C. Herisse. 2004. "Within-basin fish assemblage structure: the relative influence of habitat versus stream spatial position on local species richness." *Canadian Journal of Fisheries and Aquatic Sciences* 61:93-102 (2004), doi: 10.1139/F03-145.

HDR Alaska, Inc. 2011. *Aquatic resources data gap analysis*. Draft. Prepared for Alaska Energy Authority. July 20, 2011.

Hendricks, M. L., C. H. Hocutt, and J. R. Stauffer, Jr. 1980. Monitoring of fish in lotic habitats. In *Biological monitoring of fish*. C. H. Hocutt and J. R. Stauffer, Jr., editors. D.C. Heath, Lexington, Massachusetts. Pp. 205–31

Hughes, R, M., P. R. Kaufmann, A. T. Herlihy, S. S. Intelmann, S. C. Corbett, M. C. Arbogast, and R. C. Hjort. 2002. Electrofishing distance needed to estimate fish species richness in Medium Oregon rivers. *North American Journal of Fisheries Management* 22: 1229–1240.

Lyons, J. 1992. The length of stream to sample with a towed electrofishing unit when fish species richness is estimated. *North American Journal of Fisheries Management* 12:198-203.

Murphy, B.R. and D.W.E. Willis. 1996. Fisheries Techniques. American Fisheries Society, Bethesda, Maryland. Pp. 732.

National Marine Fisheries Service (NMFS). 2000. *Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act*.

Patton, T. M., W. A. Hubert, F. J. Rahel, and K. G. Gerow. 2000. Effort needed to estimate species richness in small streams on the Great Plains in Wyoming. *North American Journal of Fisheries Management* 20:394–398.

Reynolds, J. B. 1996. Electrofishing. In *Fisheries techniques, 2nd edition*. Murphy, B. R., and D. W. Willis, editors. American Fisheries Society, Bethesda, Maryland. Pp. 221-53.

Reynolds, L., A. T. Herlihy, P. R. Kaufman, S. V. Gregory, and R. M. Hughes. 2003. Electrofishing effort requirements for assessing species richness and biotic integrity in Western Oregon Streams. *North American Journal of Fisheries Management* 23:450-461.

Rosgen, D. L. 1994. *A classification of natural rivers*. Catena 22:169-199.

Schmidt, D, C. Estes, D. Crawford, and D. Vincent-Lang. 1984. *Access and transmission corridor aquatic investigations (July—October 1983), Report No. 4*. Susitna Hydro Aquatic Studies. APA Doc No. 2049. Alaska Department of Fish and Game, Anchorage, Alaska.

Simon, T. P. and R. E. Sanders. 1999. Applying an index of biotic integrity based on great river fish communities: considerations in sampling and interpretation. In *Assessing sustainability and biological integrity of water resources using fish communities*. T. P. Simon, editor. CRC Press, Boca Raton, Florida. Pp. 475–505

Temple, G. M., and T. N. Pearsons. 2007. Electrofishing: backpack and drift boat. Pages 95–132 in D. H. Johnson, B. M. Shrier, J. S. O'Neal, J. A. Knutzen, X. Augerot, T. A. O'Neil, and T. N. Pearsons. *Salmonid field protocols handbook—techniques for assessing status and trends in salmon and trout populations*. American Fisheries Society, Bethesda, Maryland.

U.S. Forest Service (USFS). 2001. Chapter 20—Fish and aquatic stream habitat survey. *FSH 2090-Aquatic Habitat Management Handbook* (R-10 Amendment 2090.21-2001-1).

7.13.9. Figures

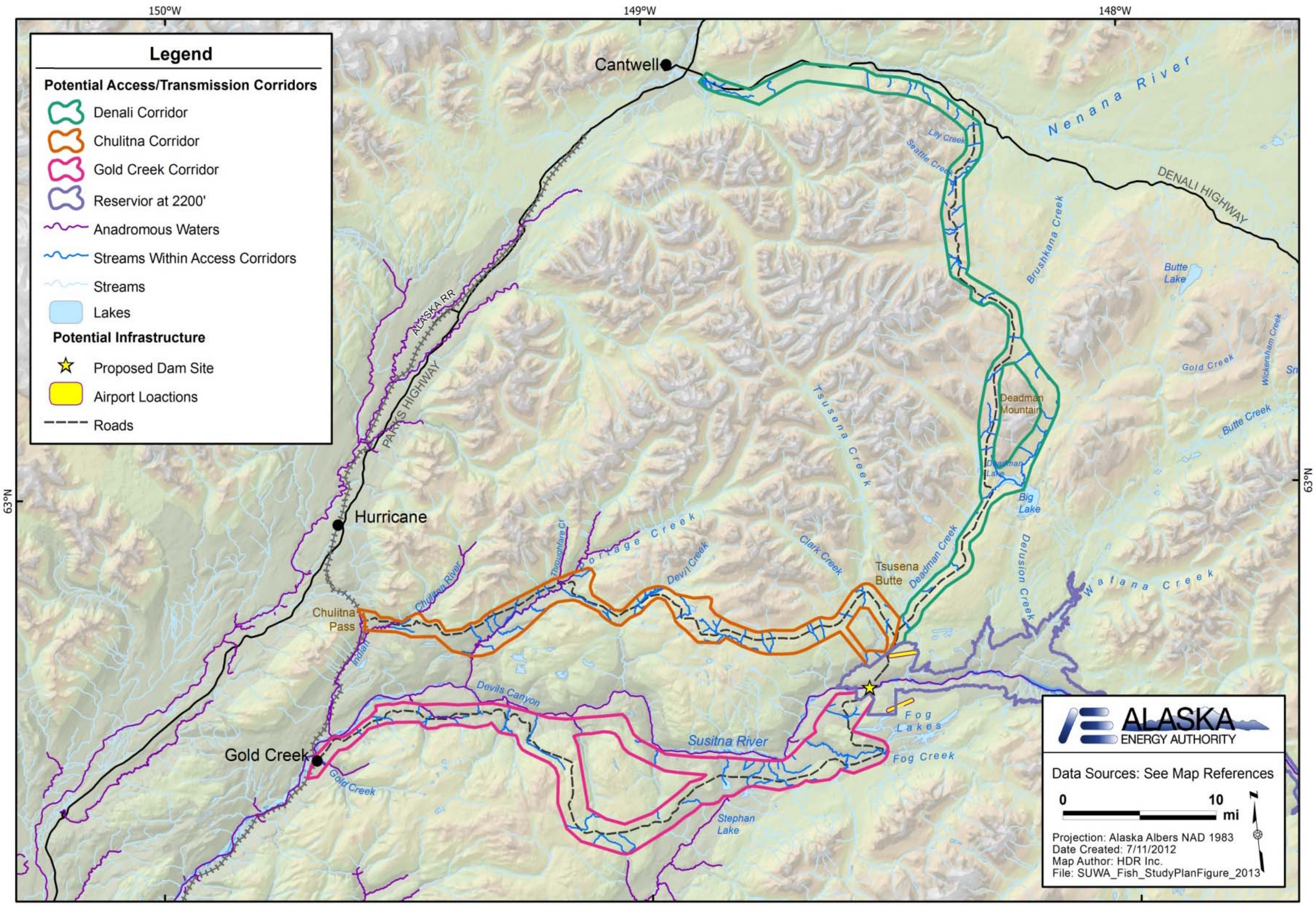


Figure 7.13-1. Study Area for Aquatic Resources in the Potential Access and/or Transmission Alignment Corridors.

7.14. Genetic Baseline Study for Selected Fish Species

7.14.1. General Description of the Proposed Study

Construction and operation of the Project will modify the flow, thermal, and sediment regimes of the Susitna River, which may alter the composition and distribution of fish populations.

Genetic analysis methods can be used to address several goals associated with assessing potential Project impacts. First, there is a potential for the Project to affect genetic diversity and local adaptation of fish populations. Second, genetics can be used as a tool to assess other forms of impacts. Ultimately, the usefulness of genetics as a tool to assess other impacts derives from the degree of population segregation of particular species among areas of the Susitna watershed. If breeding isolation among areas occurs over sufficient time, the unique genetic characteristics act as naturally occurring "tags" of spawning populations.

As part of the first application of genetics, this study will develop a repository of fish tissues from many resident and anadromous fish for use with future studies that may be needed to characterize the genetic legacy and variation for species of interest. As a tool for assessing non-genetic impacts, this study will provide a means of assessing the degree to which Chinook salmon from the middle and upper river rear in areas downstream of the middle river. If known to occur, such information alters the methods that are needed to characterize any effects from the Project. For example, monitoring the abundance of Chinook salmon smolt leaving the middle river to the sea would underestimate the actual contribution of the middle and upper river to the overall Susitna Chinook salmon population.

In addition, if sufficient genetic uniqueness exists among Chinook salmon from different tributaries exists genetics may be used to estimate the overall abundance of spawning Chinook salmon in the Susitna River watershed. For example, counts of Chinook salmon in tributaries (e.g., from counting weirs) can be combined with a sampling program of the entire spawning run obtained in lower river fishwheels to estimate the overall abundance of Susitna River Chinook salmon.

This work will be conducted through collaboration among AEA, ADF&G, and other licensing participants. Information developed in this study may also assist in the development of any necessary protection, mitigation, or enhancement measures to address potential adverse Project impacts to salmonid resources.

7.14.1.1. Study Goals and Objectives

The goals of this study are to (1) acquire genetic material from samples of selected fish species within the Susitna River drainage and (2) assess the use of lower and middle river habitat by juvenile Chinook salmon originating in the middle and upper Susitna River.

Objectives:

1. Develop a repository of genetic samples for fish species captured within the Susitna River drainage, with an emphasis on those species found in the middle and upper Susitna River.
2. Contribute to the development of genetic baseline markers for each of the five species of Pacific salmon spawning in the Susitna River drainage.

3. For 2013 and 2014, quantify the genetic variation among upper and middle river Chinook salmon for use in mixed-stock analyses, including analyses of lower river samples of the entire Susitna Chinook salmon population.
4. In 2013 and 2014, estimate the annual percent of juvenile Chinook salmon in selected lower river habitats that originated in the middle and upper Susitna River.

7.14.2. Existing Information and Need for Additional Information

The baseline genetics data in the Susitna River is limited to the five Pacific Salmon species. Assessing genetic relatedness and isolation of fishes in the watershed can be used to determine potential impacts from the Project. Interbreeding among areas might be hindered by the Project, thereby potentially reducing the fitness of some stocks of resident fishes. Breeding isolation of stocks may be a sign of uniquely adapted traits for particular features of the habitats; such information would alter the impact assessment, and possibly the design of any proposed mitigation measures. To characterize relatedness and any isolation of particular resident fishes, tissue samples for genetic analysis must be collected from a range of locations.

Tissue collections and genetic analyses of Pacific salmon stocks in Alaska are relatively well developed and are used for applied research in several watersheds. The Susitna River salmon stocks are not well represented in the State's tissue repository, and samples obtained here will enable the application of genetic methods to address two objectives. First, if sufficient genetic variation (and isolation) of Chinook stocks exists, genetics can provide a means to identify the extent to which the offspring of fish that spawn in the upper river are found rearing in the middle and lower river. Second, if tributary-specific Chinook salmon stocks in the Susitna River are unique, modern analytical methods can be used to estimate the species' system-wide escapement. Estimating the system-wide Chinook salmon escapement is part of the *Salmon Escapement Study* (Section 7.7), and the rationale and approach for it are outlined in that section.

7.14.3. Study Area

The study area encompasses the Susitna River and its tributaries from Cook Inlet upstream to the Oshetna River confluence (RM 233.4). For baseline data related to stock-specific sampling, there is an emphasis on tributaries of the middle river and the upper river. For assessing habitat use (juveniles) of fish originating in the middle and upper river, and for estimating the system-wide escapement (adults), Chinook salmon tissues will be collected in the lower river (< RM 98).

7.14.4. Study Methods

7.14.4.1. Samples to Collect

The annual targets for data collection to meet the study objectives are indicated below. The sample sizes associated with each collection listed below represent a target rather than a sample size requirement since the abundance of each species or sub-stock is currently unknown.

- 100 tissue samples from spawning Chinook salmon in Portage Creek and Indian River (Objective 1).
- 25 tissue samples from spawning Chinook salmon from any Susitna River tributary with evidence of Chinook spawning upstream in the middle and upper Susitna River. Likely

streams to sample include: Chinook, Devil, Fog, Tsusena, and Kosina creeks, and the Oshetna River (Objectives 1 and 2).

- 100 tissue samples from any mainstem spawning Chinook salmon above Devils Canyon (Objectives 1 and 2).
- 100 tissue samples from each spawning aggregate of pink, sockeye, chum, and coho salmon from the Susitna River upstream of Three Rivers (Objective 1).
- 100 tissue samples from juvenile Chinook salmon at each of the following: Chinook Creek, Oshetna River, Indian River, Portage Creek, the mainstem Susitna River upstream of Three Rivers, as well as Talkeetna and Chulitna rivers (Objectives 1, 2, and 3).
- 75 juvenile Chinook salmon 16 sites across five mainstem habitat types in the lower Susitna River (Objective 3).
- 50 representative samples from each of the following species in the Susitna River (Table 7.14-1), with an emphasis on fish collected opportunistically in the middle and upper Susitna River (Objective 4):

Table 7.14-1. Potential Susitna River Fish Species for Targeted for Genetic Analysis Sampling

Common Name	Scientific Name
rainbow trout	*Oncorhynchus mykiss*
humpback whitefish	*Coregonus pidschian*
round whitefish	*Prosopium cylindraceum*
lake whitefish	*Coregonus clupeaformes*
Alaska whitefish	*Coregonus nelsonii*
Bering cisco	*Coregonus laurettae*
eulachon	*Thaleichthys pacificus*
Pacific lamprey	*Lampetra tridentata*
longnose sucker	*Catostomus catostomus*
slimy sculpin	*Cottus cognatus*
prickly sculpin	*Cottus asper*
coastal range sculpin	*Cottus aleuticus*
Pacific staghorn sculpin	*Leptocuttus armatus*
burbot	*Lota lota*
Arctic grayling	*Thymallus arcticus*
Dolly Varden	*Salvelinus malma*
lake trout	*Salvelinus namaycush*
northern pike	*Esox lucius*
threespine stickleback	*Gasterosteus aculeatus*
ninespine stickleback	*Pungitius pungitius*
Alaska blackfish	*Dallia pectoralis*

7.14.4.2. Tissue Storage

While in the field, tissue samples will be preserved in ethyl alcohol in a 125–500 ml bulk sample bottle for each location. After samples are received by the Gene Conservation Laboratory (GCL), samples will be preserved as follows. At least five pieces of each sample will be placed into plastic plates and freeze dried. Once dry, moisture-indicating desiccant beads will be added and the plate sealed completely with aluminum foil heat-activated tape. Tissues samples will then be stored at room temperature.

7.14.4.3. Laboratory Analysis

DNA from the baseline collections will be extracted from axillary processes using DNeasy 96 tissue kits. Chinook salmon samples will be analyzed for at least 96 single nucleotide polymorphism (SNP) markers.

The DNA samples will be analyzed using Fluidigm 96.96 Dynamic Arrays (http://www.fluidigm.com). The Fluidigm 96.96 Dynamic Array contains a matrix of integrated channels and valves housed in an input frame. On one side of the frame there are 96 inlets to accept the sample DNA from each individual fish and on the other are 96 inlets to accept the assays for each SNP marker. Once in the wells, the components are pressurized into the chip using the IFC Controller HX (Fluidigm). The 96 samples and 96 assays are then systematically combined into 9,216 parallel reactions. Each reaction is a mixture of 4 µl of assay mix (1x DA Assay Loading Buffer (Fluidigm), 10x TaqMan SNP Genotyping Assay (Applied Biosystems), and 2.5x ROX (Invitrogen)) and 5 µl of sample mix (1x TaqMan Universal Buffer (Applied Biosystems), 0.05x AmpliTaq Gold DNA Polymerase (Applied Biosystems), 1x GT Sample Loading Reagent (Fluidigm), and 60-400ng/ul DNA) combined in a 6.7 nL chamber. Thermal cycling is performed on an Eppendorf IFC Thermal Cycler as follows: an initial “hot mix” of 30 min at 70 ^{o}C, and then denaturation of 10 minutes at 96 °C followed by 40 cycles of 96 ^{o}C for 15 seconds and 60 ^{o}C for 1 min. The Dynamic Arrays are read on a BioMark Real-Time PCR System (Fluidigm) after amplification and scored using Fluidigm SNP Genotyping Analysis software.

For some SNP markers, genotyping will be performed in 384-well reaction plates. Each reaction is conducted in a 5 µL volume consisting of 5-40 ng of template DNA, 1x TaqMan Universal PCR Master Mix (Applied Biosystems) and 1x TaqMan SNP Genotyping Assay (Applied Biosystems). Thermal cycling is performed on a Dual 384-Well GeneAmp PCR System 9700 (Applied Biosystems) as follows: an initial denaturation of 10 minutes at 95 °C followed by 50 cycles of 92 °C for 1 second and annealing/extension temperature for 1.0 or 1.5 minutes. The plates are scanned on an Applied Biosystems Prism 7900HT Sequence Detection System after amplification and scored using Applied Biosystems’ Sequence Detection Software (SDS) version 2.2.

All genotypes collected will be entered into the GCL Oracle database, LOKI. Quality control measures include re-extraction and re-analysis of 8 percent of each collection for all markers to insure genotypes are reproducible and to identify laboratory errors and rates of inconsistencies. Genotypes are assigned to individuals using a double-scoring system.

7.14.4.4. Data Retrieval and Quality Control

Genotypes will be retrieved from LOKI and imported into *R* (R Development Core Team 2011) with the *RODBC* package (Ripley 2010). All subsequent analyses will be performed in *R*, unless otherwise noted.

Prior to statistical analysis, three analyses will be performed to confirm the quality of the data. First, SNP markers will be identified that are invariant in all individuals or that have very few individuals with the alternate allele in only one collection. These markers will be excluded from further statistical analyses. Second, individuals will be identified that are missing substantial genotypic data because they likely have poor quality DNA. Individuals missing substantial genotypic data will be identified using the 80-percent rule (missing data at 20 percent or more of loci; Dann et al. 2009). These individuals will be removed from further analyses. The inclusion of individuals with poor quality DNA might introduce genotyping errors into the baseline and reduce the accuracies of mixed stock analyses.

The final QC analysis will identify individuals with duplicate genotypes and remove them from further analyses. Duplicate genotypes can occur as a result of sampling or extracting the same individual twice, and will be defined as pairs of individuals sharing the same alleles in 95 percent of screened loci. The sample with the most missing genotypic data from each duplicate pair will be removed from further analyses. If both samples have the same amount of genotypic data, the first sample will be removed from further analyses.

7.14.4.5. Genetic Baseline Development

7.14.4.5.1. Hardy-Weinberg expectations

For each locus within each collection, tests for conformance to Hardy-Weinberg expectations (HWE) will be performed using Monte Carlo simulation with 10,000 iterations in the *Adegenet* package (Jombart 2008). Probabilities will be combined for each collection across loci and for each locus across collections using Fisher's method (Sokal and Rohlf 1995), and collections and loci that violated HWE will be excluded from subsequent analyses after correcting for multiple tests with Bonferroni's method ($\alpha = 0.05$ per number of collections).

7.14.4.5.2. Pooling collections into populations

When appropriate, collections will be pooled to obtain better estimates of allele frequencies following a step-wise protocol. First, collections from the same geographic location, sampled at similar calendar dates but in different years, will be pooled, as suggested by Waples (1990). Then differences in allele frequencies between pairs of geographically proximate collections that were collected at similar calendar dates and that might represent the same population will be tested. Collections will be defined as being "geographically proximate" if they were collected within the same river. Fisher's exact test (Sokal and Rohlf 1995) of allele frequency homogeneity will be used, and decisions will be based on a summary across loci using Fisher's method. Collections will be pooled when tests indicate no difference between collections ($P > 0.01$). When all individual collections within a pooled collection are geographically proximate to other collections, the same protocol will be followed until significant differences are found between the pairs of collections being tested. After this pooling protocol, these final collections will be considered to be populations. Finally, populations will be tested for conformance to HWE following the same protocol described above to ensure that pooling was appropriate, and that tests for linkage disequilibrium will not result in falsely positive results due to departure from HWE.

7.14.4.5.3. Linkage disequilibrium

Linkage disequilibrium between each pair of nuclear markers will be tested for in each population to ensure that subsequent analyses are based on independent markers. The program *Genepop* version 4.0.11 (Rousset 2008) will be used with 100 batches of 5,000 iterations for these tests. The frequency of significant linkage disequilibrium between pairs of SNPs ($P < 0.05$) will then be summarized. Pairs will be considered linked if they exhibited linkage in more than half of all populations.

7.14.4.6. Analysis of Genetic Structure

7.14.4.6.1. Temporal variation

Temporal variation of allele frequencies will be examined with a hierarchical, three-level analysis of variance (ANOVA). Temporal samples will be treated as sub-populations based on the method described in Weir (1996). This method will allow for the quantification of the sources of total allelic variation and permit the calculation of the among-years component of variance and the assessment of its magnitude relative to the among-population component of variance. This analysis will be conducted using the software package *GDA* (Lewis and Zaykin, 2001).

7.14.4.6.2. Hierarchical log-likelihood tests

Genetic diversity will be examined with a hierarchical log-likelihood ratio (G) analysis.

7.14.4.6.3. Visualization of genetic distances

To visualize genetic distances among collections two approaches will be used. Both approaches are based on pairwise F_{ST} estimates from the final set of independent markers with the package *hierfstat* (Goudet 2006). The first approach is to construct 1,000 bootstrapped neighbor-joining (NJ) trees by resampling loci with replacement to assess the stability of tree nodes. The consensus tree will be plotted with the *APE* package (Paradis et al. 2004). While these trees provide insight into the variability of the genetic structure of collections, pairwise distances visualized in three dimensions are more intuitive. In a second approach, pairwise F_{ST} will be plotted in a multidimensional scaling (MDS) plot using the package *rgl* (Adler and Murdoch 2010).

7.14.4.7. Habitat utilization in the lower river by Chinook salmon progeny originating in the Middle and Upper Susitna River

If the results of the Chinook salmon genetics studies conducted during 2012 indicate that the Chinook salmon spawning upstream of Devils Canyon and in the middle river and its tributaries are sufficiently unique, ADF&G will characterize the presence and relative proportion of fish originating from the upper and middle rivers in selected lower river habitats.

In each of two years, 75 juvenile Chinook salmon from each of 16 mainstem locations (across five habitat types) will be collected and preserved as outlined above. These 1,200 tissue samples collected in each year will be analyzed and the results will be pooled into a range of spatial strata to identify any middle and upper river fish, and where feasible, estimate the proportion of fish originating from upstream of the Three Rivers Confluence (RM 98).

7.14.5. Consistency with Generally Accepted Scientific Practice

The laboratory and analytical methods to be used for this study are widely applied in North America and Asia to characterize the origin and genetic variation in salmonid and non-salmonid fish species. ADF&G's Gene Conservation Laboratory (GCL) located in Anchorage, Alaska is on the leading edge of applied fish genetics, and it has a long history of publishing techniques and results from its studies in the peer-reviewed literature. GCL personnel serve on many multi-national scientific work groups from around the Pacific Rim.

7.14.6. Schedule

- Baseline sample collection: June through October 2013 and 2014 (in conjunction with other AEA field studies).
- Mixture sample collection from the lower river: June through August 2013 and 2014.
- Analysis of juvenile and adult Chinook salmon tissue: November 2013 through December 2014.
- Initial and Updated Study Reports explaining actions taken and data collected to date will be issued in December 2013 and 2014, respectively.

7.14.7. Level of Effort and Cost

The total estimate for the cost of the study over two years is approximately $625,000 - $800,000. The estimated cost for each of the four study objectives described above is as follows:

1) $160,000–$180,000 annually
2) $32,000 for the 2013 field season
3) $100,000-$150,000 annually
4) $36,000–$53,000 annually

7.14.8. Literature Cited

Adler, D., and D. Murdoch. 2010. rgl: 3D visualization device system (OpenGL). R package version 0.91. http://CRAN.R-project.org/package=rgl.

Beacham, T. D., M. Wetklo, C. Wallace, J. B. Olsen, B. G. Flannery, J. K. Wenburg, W. D. Templin, A. Antonovich, and L. W. Seeb. 2008. The application of microsatellites for stock identification of Yukon River Chinook salmon. North American Journal of Fisheries Management 28:283-295.

Dann, T. H., C. Habicht, J. R. Jasper, H. A. Hoyt, A. W. Barclay, W. D. Templin, T. T. Baker, F. W. West, and L. F. Fair. 2009. Genetic stock composition of the commercial harvest of sockeye in Bristol Bay, Alaska, 2006–2008. Alaska Department of Fish and Game, Fishery Manuscript Series No. 09-06, Anchorage.

Goudet, J. 2006. hierfstat: Estimation and tests of hierarchical F-statistics. R package version 0.04-4. http://www.r-project.org, http://www.unil.ch/popgen/softwares/hierfstat.htm

Jombart, T. 2008. Adegenet: a R package for the multivariate analysis of genetic markers. Bioinformatics 24: 1403-1405. doi: 10.1093/bioinformatics/btn129.

Lewis, P. O., and D. Zaykin. 2001. Genetic data analysis: computer program for the analysis of allelic data. Version 1.0. URL http://lewis.eeb.uconn.edu/lewishome/software.html.

Paradis, E., J. Claude, and K. Strimmer. 2004. APE: analyses of phylogenetics and evolution in R language. Bioinformatics 20: 289–290.

R Development Core Team. 2011. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/.

Ripley, B. 2010. RODBC: ODBC Database Access. R package version 1.3-2. http://CRAN.R-project.org/package=RODBC.

Rousset, F. 2008. GENEPOP ' 007: a complete re-implementation of the GENEPOP software for Windows and Linux. Molecular Ecology Resources 8(1):103–106.

Seeb, L. W., N. A. DeCovich, A. W. Barclay, C. T. Smith, and W. D. Templin. 2009. Timing and origin of Chinook salmon stocks in the Copper River and adjacent ocean fisheries using DNA markers. Alaska Department of Fish and Game, Fishery Data Series No. 09-58, Anchorage.

Smith, C. T., W. D. Templin, J. E. Seeb, and L.W. Seeb. 2005a. Single nucleotide polymorphisms (SNPs) provide rapid and accurate estimates of the proportions of U.S. and Canadian Chinook salmon caught in Yukon River fisheries. North American Journal of Fisheries Management 25:944-953.

Sokal, R. R. and F. J. Rohlf. 1995. Biometry. 3rd Edition. Freeman, San Francisco, CA.Thomas, A., O'Hara, B., Ligges, U., and Sturtz, S. 2006. Making BUGS Open. R News 6 (1): 12-17.

Templin, W. D., N. A. DeCovich, and L. W. Seeb. 2008. Genetic stock identification of Chinook salmon harvest on the Yukon River, 2006. Alaska Department of Fish and Game, Fishery Data Series No. 08-15, Anchorage.

Templin, W.D., N.A. Decovich, J.D. Guyon, S.E. Gilk-Baumer, D.B. Molyneaux, and L.W. Seeb. 2011. Genetic stock identification of Kuskokwim Area Chinook salmon. USFWS Office of Subsistence Management, Fisheries Resource Monitoring Program, Final Report for Study No. 05-305, Anchorage, Alaska.

Waples, R. S. 1990. Temporal changes of allele frequency in Pacific salmon: implications of mixed-stock fishery analysis. Canadian Journal of Fisheries and Aquatic Sciences 47:968–976.

Weir, B. 1996. Genetic Data Analysis (second edition). Sinauer Associates, Inc, Sunderland, MA.

7.15. Analysis of Fish Harvest in and Downstream of the Susitna-Watana Hydroelectric Project Area

7.15.1. General Description of the Proposed Study

Information from this fish harvest study will be used in combination with other studies to assess potential effects of the proposed Project on fisheries resources. Harvest study results will be used to inform the licensing process by analyzing baseline harvest data from the Project area downstream to where the Susitna River joins Upper Cook Inlet and into the marine waters of the Upper Cook Inlet commercial fisheries management area (Figure 7.15-1). This study will provide a basis for impact assessment and developing any potential protection, mitigation, and enhancement measures, if necessary.

7.15.1.1. Study Goals and Objectives

The goal of this study is to compile and analyze baseline information on the harvests of resident and anadromous fishes in and downstream of the proposed Project area to understand the potential for Project construction and operation to alter harvest levels and opportunity. This study has two primary objectives:

1. Describe baseline harvest levels and harvest locations for commercial, sport, personal use, and subsistence fisheries for Susitna River origin resident and anadromous fish; and
2. Describe the potential for the Project to alter harvest levels and opportunities on Susitna River origin resident and anadromous fish based on potential Project-induced changes in fish abundance and distribution from flow- and habitat-related changes as estimated from other Project studies.

7.15.2. Existing Information and Need for Additional Information

The ADF&G documents legal catches from commercial, sport, personal use and subsistence fisheries. Fishing effort and harvest success data are collected annually by fishery, management area, district, subdistrict, and in some cases by smaller statistical harvest reporting areas. Historic harvest statistics are stored by ADF&G in a variety of statewide databases.

7.15.2.1. Commercial Fisheries

The Susitna River watershed is within the Upper Cook Inlet Management Area (UCIMA) for commercial fisheries. Commercial salmon fisheries in the UCIMA target salmon stocks bound for the major river systems of Cook Inlet, including the Susitna River. Salmon are harvested during seasons and according to regulations established by the Alaska Board of Fisheries. The ADF&G Division of Commercial Fisheries, based in Soldotna, monitors salmon returns in Cook Inlet and sets fishing periods based on the perceived strength of the returns to achieve escapement goals for the major rivers of the area. The UCIMA includes central and northern districts (Figure 7.15-1), each being further divided into subdistricts (Shields and Dupuis 2012). Two commercial gear types are permitted in the limited entry commercial fishery: drift gill nets (Central District only) and set gill nets (allowed in portions of both districts). Commercial harvests are recorded at the time of sale on a fish ticket, which includes the date, location code (statistical area), and the number and pounds of each species of salmon delivered. These data are stored in a statewide fish ticket database.

Five species of Susitna River salmon are commercially harvested in Upper Cook Inlet: Chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), chum (*O. keta*), pink (*O. gorbuscha*), and coho salmon (*O. kisutch*). Sockeye salmon make up the largest component of the harvest and commercial value. Harvest data are summarized and reported annually by the ADF&G Division of Commercial Fisheries (Shields and Dupuis 2012). The ADF&G Gene Conservation Laboratory has successfully used genetic mixed stock analysis techniques to identify stock-of-origin in commercial fishery catches such that the contribution of Susitna River-origin sockeye salmon can be estimated (Barclay et al. 2010). Efforts are underway to develop the baseline and resolution for other salmon species.

Eulachon (*Thaleichthys pacificus*), also known as smelt or hooligan, are harvested commercially in the UCIMA (Shields and Dupuis 2012; Shields 2005, 2010). Managed under the *Cook Inlet Smelt Fishery Management Plan* (5 AAC 21.505), the fishery has a harvest cap of 100 tons. Harvesters use dip nets, and a majority of the harvest is taken in the vicinity of the Susitna River delta. Harvest statistics have been reported since 1978; the 2011 season was the first year in which the harvest cap was reached (Shields and Dupuis 2012).

7.15.2.2. Sport Fisheries

The Susitna watershed lies within the Northern Cook Inlet Management Area (NCIMA) (Figure 7.15-2) established for the management of recreational fisheries. For the purposes of harvest reporting the NCIMA is divided into four subunits:

- Knik Arm Management Unit lying south of Willow Creek and east of the Susitna River;
- Eastside Susitna Management including all waters of the upper Susitna River above the Chulitna River to and including the Oshetna River;
- Westside Susitna Management Unit including the Chulitna and Yentna rivers; and
- West Cook Inlet Unit including freshwater drainages entering Cook Inlet to the west of the Susitna River mouth (Figure 7.15-2).

Sport fisheries in the NCIMA are managed by the ADF&G Division of Sport Fisheries office in Palmer. The Statewide Harvest Survey (SWHS) annual postal survey of sport fish license holders is the primary method used by ADF&G to compile harvest estimates for NCIMA sport fisheries (Jennings 2007). Sport fishing harvest and effort by species have been estimated and reported annually for the four NCIMA management units since 1977.

Sport fisheries in the NCIMA target the five species of Susitna River salmon, with coho salmon and Chinook salmon making up the largest contributions to the harvest (Jennings 2007). Other species taken in the sport fishery, ordered by amount harvested, include northern pike (*Esox lucius*), rainbow trout (*O. mykiss*), Arctic grayling (*thymallus arcticus*), lake trout (*Salvelinus namaycush*), Dolly Varden (*S. malma*), burbot (*Lota lota*), round whitefish (*Prosopium cylindraceum*) and humpback whitefish (*Coregonus clupeaformis*) (Jennings 2004).

7.15.2.3. Personal Use Fisheries

Three personal use fisheries currently occur within the NCIMA:

- A sockeye salmon dip net fishery at Fish Creek located in Knik Arm;
- A dip net fishery for Alaska residents 60 years or older at the Beluga River (to the west of the Susitna River mouth); and
- A eulachon fishery in the Lower Susitna River (Oslund and Ivey 2010).

Participants in these fisheries obtain a permit from ADF&G and are required to record daily harvest information on the permit. Permits are returned to ADF&G at the end of the season. Personal use harvest data are reported annually in ADF&G annual management reports (for example, Ivey et al. [2009]).

7.15.2.4. Subsistence Fisheries

Subsistence fishing regulations in the Susitna River watershed are complex and restrictive. A portion of the watershed falls within a “nonsubsistence area” defined under the Alaska Administrative Code (AAC) 5 AAC 99.015 (3). Trout, char, grayling, and burbot may not be taken for subsistence in fresh water (5 AAC 01.575. (c)). The only subsistence salmon fishery authorized within the Susitna watershed is a fishwheel fishery on the upper Yentna River near the community of Skwentna (5 AAC 01.593). A subsistence gill net fishery is authorized in the Tyonek drainage for whitefish (5 AAC 01.580), and smelt may be taken in fresh and salt water (5 AC 01.599). A coastal set gill net subsistence fishery operates near the community of Tyonek in Northern Cook Inlet, which targets salmon returning to the Susitna and other river systems of northern Cook Inlet. Educational subsistence fisheries are permitted on the east side of the Central District between Kenai and Anchor Point.

Subsistence salmon harvest data are reported annually in ADF&G annual fishery management reports (for example Oslund and Ivey, 2010, and Shields and Dupuis, 2012) and in the Alaska subsistence salmon fisheries annual reports (for example, Fall et al. 2011). Historic subsistence harvest data are stored in the Alaska Subsistence Fisheries Database (ASFDB) managed by the ADF&G Division of Subsistence in Anchorage (Caylor and Brown 2006). Harvest data for non-salmon species may not be regularly reported.

7.15.2.5. Additional information needs

To assess potential Project effects on harvest rates, it is necessary to draw upon other studies that are designed to estimate abundance and distribution of the various fish stocks in the Susitna River system. Existing information includes fish spatial and temporal distribution and relative abundance information from recent and early 1980s studies. The *Aquatic Resources Data Gap Analysis* (HDR 2011) and the *Susitna-Watana Hydroelectric Project Pre-Application Document* (AEA 2011) summarized existing information and identified data gaps for adult salmon, resident and rearing fish, and for subsistence resources (Northern Land Research, Inc. 2011). In recent years, ADF&G has conducted adult salmon (sockeye, coho, and chum salmon) spawning distribution and abundance studies in the Susitna River (e.g., Yanusz et al. 2011, Merizon et al. 2010). In 2012, ADF&G expanded its scope to include Chinook and pink salmon. Concurrent studies to be conducted as part of the licensing process for the Project include salmon escapement and run apportionment, fish distribution and abundance in the Susitna River, characterization of aquatic habitats in the Susitna River, and subsistence use.

7.15.3. Study Area

The study area includes the Susitna River from its mouth upstream to and including the Oshetna River (RM 233.4). The study area includes tributaries that are connected to the mainstem of the Susitna and marine waters of Upper Cook Inlet where anadromous fish species originating from the Susitna River are intercepted in commercial fisheries north of the latitude of Anchor Point (59° 46.15’ N. lat.).

7.15.4. Study Methods

Baseline data on commercial, sport, personal use, and subsistence harvests of resident and anadromous fish in the Project area and other potentially affected areas downstream of the Project will be gathered and synthesized. Specific tasks include compilation and apportionment of ADF&G commercial harvest records, compilation of harvest and effort from sport fisheries, compilation of harvest and effort from personal use fisheries, compilation of subsistence harvest data, and evaluation of potential project effects. These data will be used in combination with the results of fish abundance studies conducted as part of Project licensing to assess potential Project impacts; further, these data will feed into analyses to be completed by recreation, socioeconomic and subsistence study teams. Specific methods are detailed below.

7.15.4.1. Compilation and Apportionment of ADF&G Commercial Harvest Records

Evaluating potential Project effects on commercially harvested fish species is a two-step process to identify: 1) how many Susitna River fish are harvested in the area’s commercial fisheries, and 2) how many of those fish use mainstem Susitna River habitats that have the potential to be impacted.

Investigators will contact ADF&G Commercial Fisheries staff in area and regional offices to better understand the spatial and temporal resolution of commercial harvest records in the UCIMA. Harvest statistics for each of the salmon species commercially harvested in the UCIMA are stratified spatially and temporally and are reported annually (Shields and Dupuis 2012). Investigators will compile a minimum of 20 years of harvest and effort statistics from the ADF&G statewide fish ticket database. Data will be requested at the smallest geographic reporting units (statistical areas) and time strata. The number of fish and pounds harvested by species, by day, and by harvest area will be compiled, and trends will be noted. Minimum, maximum, and mean harvest statistics will be calculated over the 20-year period. These data represent a mixture of stocks returning to a combination of river systems draining into Upper Cook Inlet. A review of available genetic stock identification studies will be used to estimate the proportion of Susitna River stocks in the harvest mixtures. Genetic stock composition data are of higher resolution for sockeye salmon (Barclay et al. 2010) than for other species, though some progress has been made apportioning chum and coho salmon stocks (Merizon et al. 2010). Species that lack sufficient genetic data for run apportionment will be assessed based on the best available geographic distribution and timing information from telemetry studies, escapement counts, and harvest reports.

Commercial harvest data from the eulachon fishery will be requested from the state database at the smallest temporal strata that will produce meaningful interpretation. Because of low participation, broad time strata may be required to prevent the identification of individual fishermen. Because the eulachon fishery takes place at the Susitna River mouth, all reported harvest will be assumed to represent stocks potentially affected by the Project.

7.15.4.2. Compilation of Harvest and Effort from Sport Fisheries

Sport fishery harvest and effort data for the 13 species identified above will be compiled at the finest geographic resolution available for freshwater fisheries in the Susitna watershed. Catch, harvest, and angler-day information will be compiled for a minimum of 20 years, and minimum, maximum, and mean values calculated by geographic area. Sources of information will include annual management reports from the ADF&G Sport Fish Division (e.g. Ivey et al. 2009) and from statewide harvest reports (e.g., Jennings et al. 2007). ADF&G Division of Sport Fish staff will be interviewed to better interpret the data available from the SWHS, and to uncover whether focused creel surveys have been conducted in select Susitna tributaries. In general, SWHS estimates from smaller fisheries with low participation are less accurate than those of larger fisheries (Mills and Howe 1992). Additional interviews may be conducted with guides and lodge owners in the Susitna River area to address low participation fisheries.

7.15.4.3. Compilation of Harvest and Effort from Personal Use Fisheries

Harvest and effort data will be compiled for the Fish Creek and Beluga River personal use salmon fisheries. Sources of information will include annual management reports from the ADF&G Sport Fish Division, for example Ivey et al. (2009). These fisheries target stocks returning to a number of river systems including the Susitna River; hence the likelihood of detecting significant Project effects is low. Regardless, harvest and effort data will be compiled for the eulachon fishery at the mouth of the Susitna River from permit return data and annual reports produced by ADF&G.

7.15.4.4. Compilation of Subsistence Harvest Data

All Cook Inlet subsistence fisheries will be reviewed. However, due to their proximity to the Susitna River watershed it is likely that the only fisheries that would have any potential linkage to the Susitna Project are the Tyonek gill net fishery and the Yentna fishwheel fishery. A minimum of 20 years of harvest and effort data will be compiled for the Tyonek Subdistrict subsistence gill net fishery from the ASFDB and/or available reported harvest data. Because this is a marine fishery, an estimate will need to be made as to the proportion of Susitna River stocks in the harvests. The estimate will use available genetic stock identification information (e.g., Barclay et al. 2010) and other sources such as run timing and proximity to other salmon systems. Harvest statistics will be compiled for the fishwheel fishery on the upper Yentna River near the community of Skwentna.

7.15.4.5. Evaluation of Potential Project Effects

Evaluating the potential for flow- and habitat-related changes to alter harvest rates for Susitna River fishery resources will require an integration of the results from multiple studies. Potential effects will differ based on species, fishery type, fishery location, life history and periodicity of affected species, and the magnitude of flow and habitat effects and other Project-related changes. The following studies initiated in 2012 and/or conducted during 2013–2014 will provide information useful for evaluating effects on fish harvest and opportunity.

- The *River Flow Routing and Instream Flow Models Data Collection* initiated in 2012 will predict stage versus discharge relationships for approximately 100 transects in the mainstem of the Susitna River below the proposed reservoir.
- The *Aquatic Habitat and Geomorphic Mapping of the Middle River Study* will provide a comparison of the habitat mapping conducted in the 1980s with habitat mapping developed at similar discharges in 2012. One of the intents of the *Geomorphic Mapping Study* is to help address the potential effect of Project operations on the stability of tributary mouths and access to tributaries within the middle Susitna River. It is also intended to provide baseline information to evaluate the influence of Project-induced changes to mainstem water surface elevations in July through September on adult salmon access to upland sloughs, side sloughs, and side channels used for spawning.
- The *Fish Passage Barriers Study* (Section 7.12) will help inform how Project-induced changes to mainstem water surface elevations in July through September influence adult salmon access to upland sloughs, side sloughs, and side channels.
- The *Upper Susitna River Fish Distribution and Habitat Study* will quantify the amount of riverine habitat likely to be lost due to inundation and interruption of fish passage.
- The *Susitna-Watana Instream Flow Study* (IFS) is focused on development of macrohabitat specific models that can reliably estimate flow-habitat response patterns for different species and life stages of fish and other aquatic biota.
- The *Salmon Escapement and Run Apportionment Study* will provide a watershed perspective on the salmon returns to the Susitna River and apportion runs to the major tributaries (Yentna River, Chulitna River, Talkeetna River, etc.) as well as the mainstem areas potentially affected by the Project.

A synthesis of the results from these studies will be required to estimate Project effects on fisheries as a proportion of the returns to the entire Susitna watershed. It is important to note that there will be high inter-annual variability in fish abundance estimates used to quantify potential impacts; in some cases the error associated with these estimates may exceed harvest levels for a particular fishery. For this reason, potential changes to harvest level and opportunity will be expressed as a range.

Potential effects to marine fisheries

For commercial salmon fisheries in the Northern and Central Districts and the Tyonek subsistence salmon fishery, estimates of harvest rates for Susitna River stocks based on genetic stock allocation will be analyzed to quantify potential effects on harvests. Northern District set gill net fisheries likely harvest a higher proportion of Susitna River salmon than Central District drift and set gill net fisheries. Thus, effects will need to be assessed by district and on a gear type basis. Outputs from the flow routing model and riverine process models developed as part of the instream flow studies will provide simulations of Project effects under various proposed operational scenarios. These localized effects from the models will need to be put into the context of population level of harvested species within the Susitna River system and the mixtures of Susitna River and non-Susitna River stocks in the marine fisheries in the Northern and Central districts of the UCIMA. Potential impacts will be analyzed over the 20-year record of harvest.

Potential effects to eulachon fisheries

Eulachon harvested in the commercial and personal use fisheries operating in the mouth of the Susitna River will be treated as a single stock in the effects analysis. Abundance estimates generated from the fish distribution and abundance study of the PSP, coupled with the reported harvest information, will be used to estimate exploitation rates for the years that abundance data are available. Quantitative estimates of Project effects resulting from proposed operational scenarios will be obtained from the flow routing model and riverine process models developed as part of the instream flow studies.

Potential effects to sport fisheries

Effects on sport fisheries will be analyzed spatially and on a species-by-species basis within the Susitna River system. Potential Project effects within the reservoir and tributaries upstream of the proposed dam site will be assessed by studies conducted in 2013-2014 as part of the Project licensing process, i.e., the fish distribution and abundance study, the aquatic habitat study, the fish passage study, and the instream flow study and related operational models. Analysis will be conducted on a species-by-species basis taking into account migratory versus non migratory and other life history characteristics. The future Watana Reservoir fish community study will provide information on potential sport fishing opportunities anticipated in the proposed Project reservoir.

Middle and Lower River sport fisheries will be analyzed spatially and on a species-by-species basis. Outputs from the flow routing model and riverine process models developed as part of the instream flow studies will provide quantitative results of Project effects under various proposed operational scenarios. These localized effects will need to be put into the context of the species populations within the major tributaries of the Susitna River system to estimate potential effects on harvest opportunity and catch rates.

7.15.5. Consistency with Generally Accepted Scientific Practices

This study plan was developed by fisheries scientists in consultation with ADF&G and USFWS. The data used in this study have been and will be collected by ADF&G as part of their annual harvest assessments and rely upon regionally accepted methods for estimation of harvest.

7.15.6. Schedule

Harvest and effort statistics will be compiled in 2013 along with a synthesis of the best available genetic apportionment of salmon stocks harvested in commercial and subsistence fisheries. Analyses of potential Project-related effects on harvest levels and opportunity will be conducted in 2014 as results from other Project studies become available. Initial and Updated Study Reports discussing actions taken to date will be issued in December 2013 and 2014, respectively.

7.15.7. Level of Effort and Cost

This study will focus on compiling and analyzing existing harvest data and new data collected from other fish, habitat, subsistence, and recreational studies. This study will be primarily a desktop exercise. It is estimated that this study will cost approximately $200,000.

7.15.8. Literature Cited

Alaska Energy Authority (AEA). 2011. *Pre-application Document: Susitna-Watana Hydroelectric Project FERC Project No. 14241*. December 2011. Prepared for the Federal Energy Regulatory Commission, Washington, DC.

Barclay, A. W., C. Habicht, W. D. Templin, H. A. Hoyt, T. Tobias and T. M. Willette. 2010. *Genetic stock identification of Upper Cook Inlet sockeye salmon harvest, 2005–2008*. Alaska Department of Fish and Game, Fishery Manuscript No. 10-01.

Caylor, D.A. and L.A. Brown. 2006. *Alaska subsistence fisheries database Version 3.5 for Microsoft Access*. Alaska Department of Fish and Game, Division of Subsistence, Juneau, Alaska.

Fall, J. A. and D. J. Foster. 1987. *Fish and game harvest and use in the Middle Susitna Basin: the results of a survey of residents of the road-connected areas of Game Management Units 14B and 16A, 1986*. Technical Paper No. 143. Alaska Department of Fish and Game, Division of Subsistence, Juneau, Alaska.

Fall, J.A., C. Brown, N. Braem, J. Simon, W. Simeone, D. Holen, L. Naves, T. Lemons, and T. Krieg. 2011. *Alaska subsistence salmon fisheries 2008 annual report*. Technical Paper No. 359. Alaska Department of Fish and Game, Subsistence Division. Anchorage, Alaska.

HDR Alaska, Inc. 2011. *Aquatic resources data gap analysis*. Draft. Prepared for Alaska Energy Authority. July 20, 2011.

Ivey, S., C. Brockman, and D. Rutz. 2009. *Area management report for the recreational fisheries of Northern Cook Inlet, 2005 and 2006*. Alaska Department of Fish and Game, Fishery Management Report No. 09-27, Anchorage.

Jennings, G.B., K. Sundet, and A. Bingahm. 2007. *Participation, catch, and harvest in Alaska sport fisheries during 2004*. Fisheries Data Series No. 07-40. Alaska Department of Fish and Game, Division of Sport Fisheries, Anchorage, Alaska.

Merizon, R. A., R. J. Yanusz, D. J. Reed, and T. R. Spencer. 2010. *Distribution of spawning Susitna River chum* Oncorhynchus keta *and coho* O. kisutch *salmon, 2009*. Alaska Fishery Data Series No. 10-72. Department of Fish and Game, Divisions of Sport and Fish and Commercial Fisheries.

Mille, M.J. and A. Howe. 1992. *An evaluation of estimates of sport fish harvest from the Alaska statewide mail survey*. Alaska Department of Fish and Game, Special Publication No. 92-20, Anchorage.

Northern Land Research, Inc. 2011. *Watana hydroelectric project subsistence data gap analysis*. Prepared for the Alaska Energy Authority, Fairbanks. 87 pp.

Oslund, S. and S. Ivey. 2010. *Recreational fisheries of northern Cook Inlet, 2009—2010: A report to the Alaska Board of Fisheries, February 2011*. Alaska Department of Fish and Game, Fishery Management Report No. 10-50, Anchorage.

Shields, P. 2010. *Upper Cook Inlet commercial fisheries annual management report, 2011*. Alaska Department of Fish and Game, Fishery Management Report No. 12-25, Anchorage.

Shields, P., and A. Dupuis. 2012. *Upper Cook Inlet commercial fisheries annual management report, 2010*. Alaska Department of Fish and Game, Fishery Management Report No. 10-54, Anchorage.

Yanusz, R. J., R. A. Merizon, T. M. Willette, D. G. Evans, and T. R. Spencer. 2011. *Inriver abundance and distribution of spawning Susitna River sockeye salmon* (Oncorhynchus nerka)*, 2008*. Alaska Fishery Data Series No. 11-12. Department of Fish and Game, Divisions of Sport and Fish and Commercial Fisheries.

7.15.9. Figures

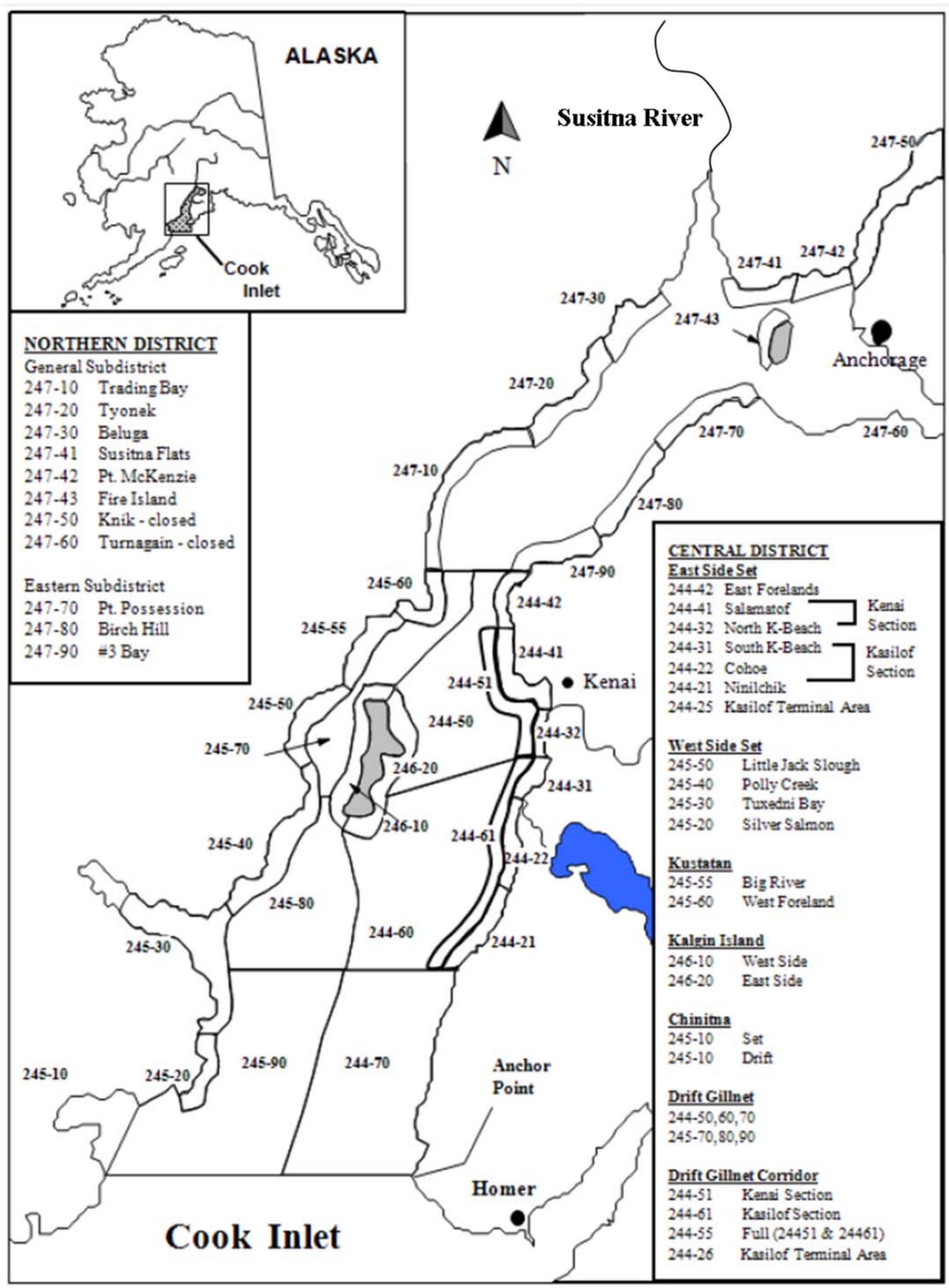


Figure 7.15-1. Upper Cook Inlet Management Commercial Fishing Districts and Statistical Reporting Areas (Shields 2012).

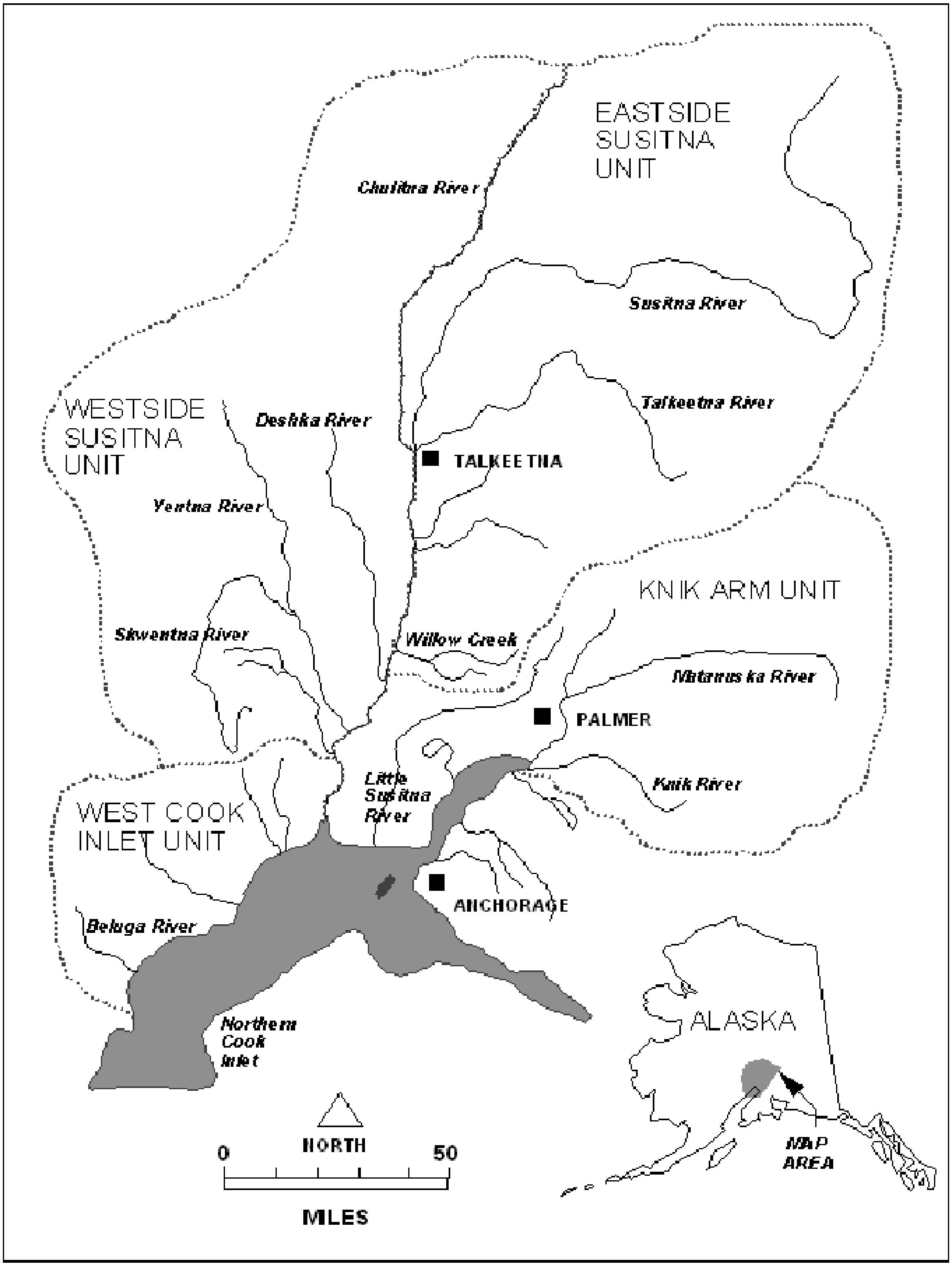


Figure 7.15-2. Northern Cook Inlet Management Area Sport Fishing Management Units (Oslund and Ivey 2010).

7.16. Eulachon Distribution and Abundance in the Susitna River Study

7.16.1. General Description of the Proposed Study

7.16.1.1. Study Goals and Objectives

The overarching goal of the study is to collect baseline information regarding eulachon (*Thaleichtys pacificus*) in the Susitna River. Eulachon are a prey species for Cook Inlet Beluga Whale (CIBW: *Delphinapterus leucas*; studies on other prey species [i.e. Pacific salmon] will be conducted under Section 7.5 Study of Fish Distribution and Abundance in the Upper Susitna River, Section 7.6 Study of Fish Distribution and Abundance in the Middle and Lower Susitna River, and Section 7.7 Salmon Escapement) and provide commercial, personal use, subsistence, and sport fisheries in the Upper Cook Inlet. Information on eulachon distribution, habitat use, and population structure in the study area will be used, along with data gathered from other studies (e.g. habitat characterization, instream flow, flow routing, water quality, Cook Inlet Beluga Whale) to assess potential Project-induced effects on these resources.

Together with existing information, the data collection described in this study plan will provide necessary baseline information to address issues identified in the Pre-Application Document and assess potential Project effects (AEA 2011).

The objectives of the eulachon study are as follows:

1. Determine the timing and duration of the spawning migration of eulachon in the Susitna River;
2. Determine eulachon spawning site distribution;
3. Identify and characterize eulachon spawning habitats;
4. Evaluate the density of eulachon at spawning habitats;
5. Document lengths, weights, and age structure of the eulachon population;
6. Collect genetic baseline samples to support ADF&G's stock analysis; and
7. Document incidental observations of marine fish species.

7.16.2. Existing Information and Need for Additional Information

7.16.2.1. Background Information

Eulachon are relatively small (<250 millimeter [9.84 inches] fork length) 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). Eulachon are anadromous, traveling short distances up river to spawn after ice-out (Scott and Crossman 1973). In most cases, a eulachon spawns once in its life; however, some individuals have been found to spawn twice (Scott and Crossman 1973).

Eulachon consist of up to 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, make them an important prey resource of CIBWs (NMFS 2008). CIBWs are opportunistic feeders and high prey densities are needed for successful foraging (NMFS 2008). Stomach content analyses from 21 CIBWs from 1995 to 2007 indicate that they consume eulachon in the spring during the eulachon's migration into Upper Cook Inlet (NMFS 2008). In 2011, NMFS formally listed eulachon as a Primary Constituent Element (PCE) essential for the conservation of CIBWs (76 FR 20180).

A small commercial and personal use fishery for eulachon has operated at the mouth of the Susitna River periodically from 1978 to 1999 and continuously from 2005 to the present (Shields and Dupuis 2012). Since 2005, the total commercial fishery for eulachon is not permitted to exceed 100 tons per year, with a six-year average of 62.4 tons per year of eulachon (Shields and Dupuis 2012). Between 2006 and 2011, the ADF&G has sampled approximately 200 eulachon each year from the commercial fisheries harvest for age, length, and sex (Shields and Dupuis 2012). ADF&G found three age classes of eulachon (3, 4, and 5), with the age-4 class consistently representing the majority of fish (Shields and Dupuis 2012). These results differ from the data collected during the 1980s Susitna Project studies, where age-3 fish constituted the dominant age class (ADF&G 1983b, 1984).

7.16.2.2. Historic Information

The Susitna River eulachon population was studied during the 1980s. At that time, it was determined that two spawning migration peaks existed in the river (approximately mid-May through late-May and early June through mid-June) (Vincent-Lang and Queral 1984). During these studies, ADF&G surveyed by boat-based electrofishing from river mile (RM) 4.5 upstream to RM 60; however, they found the uppermost extent of eulachon spawning was approximately at RM 50 (Little Willow Creek; ADF&G 1983a). Recent anecdotal reports indicate that eulachon may be present upstream to the Talkeetna area (RM 97; Mike Wood pers. comm. 2012).

Studies in the 1980s also indicated that eulachon were likely the most abundant fish species in the Susitna River (Vincent-Lang and Queral 1984). Given their high abundance, eulachon were chosen as an evaluation species for the instream flow study (ADF&G 1983a). Potential Project-related impacts to eulachon that were identified were related to decreased mainstem discharge and increased surface water temperatures during the period of the eulachon spawning migration (May through June) (Vincent-Lang and Queral 1984). During 1982 and 1983, ADF&G initiated studies to identify the relationship between naturally occurring hydrologic and water temperature and spawning migrations of eulachon (1983a, b). These studies identified eulachon spawning habitats at 20 locations between RM 8.5 and RM 44 (ADF&G 1983a). Water depth, water velocity, surface water temperature, water quality, and substrate composition were sampled and summarized (ADF&G 1983a, b; Vincent 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 (Vincent-Lang and Queral 1984). Riffle habitats along the mainstem of the Susitna River were most often used for spawning (Vincent-Lang and Queral 1984). The substrate most frequently used for spawning was silt to silty sand intermixed with gravel and rubble (Vincent-Lang and Queral 1984).

During the 1983 studies, eulachon were captured with sinking gill nets 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 then as either inmigrating fish (pre-spawning and spawning) or outmigrating fish (post-spawning) (ADF&G 1984). In addition to gill netting at

RM 4, 100 eulachon were captured by hand dip nets to characterize sex and condition (ADF&G 1984). Age (otoliths), length (fork length to the nearest millimeter [0.04 inches]), and weight (nearest 0.1 gram) were also measured from the first 10 pre-spawning eulachon of each sex (ADF&G 1984). Age analysis indicated that three-year-old fish were the dominant age class in both peaks (ADF&G 1984). The length/weight analysis indicated that eulachon in the first peak were generally larger and weighed more suggesting a more robust structure during the first peak (ADF&G 1984).

During 1983, the main channel was sampled 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 criteria were met:

1. Fish captured at the site freely expel eggs or milt;
2. Fish are in vigorously free-swimming condition; and
3. Twenty or more fish that meet Criteria 1 and 2 are caught in the initial or subsequent site sampling effort (ADF&G 1983c).

A total of 61 eulachon spawning locations were identified (ADF&G 1984).

Data on the catch per unit effort (CPUE) of eulachon indicated that the June portion of the run was composed of more fish than the first part of the run in May. During the spawning migration, there were more spawning males in the river than females, indicating that males mature earlier and spawn over a longer time 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 (38.3°F) and 10.5°C (50.9°F) (ADF&G 1984).

7.16.2.3. Need for Additional Information

Given the importance of eulachon to CIBWs, personal use, and commercial fisheries, the information on eulachon from the 1980s studies needs to be updated and expanded upon to fully evaluate potential Project impacts. Information on run timing and duration of the migration period is needed to analyze eulachon densities. Because CIBWs are opportunistic feeders and require high densities of prey, changes in eulachon densities that could potentially occur as a result of the Project may impact CIBW foraging success. Information is also needed to determine the upstream extent of eulachon spawning and to quantify the available spawning habitat. Spawning site characterization is needed to allow modelers to estimate the amount of habitat that would be available with the Project in place and operating. Biological parameters, such as age, fork length, weight, and sex are needed to provide information on the age structure and length-weight ratio to assess the energetic value of eulachon to CIBWs. Limited data from the Upper Cook Inlet Eulachon Commercial Fishery may reveal that eulachon size and age are different from what was observed in the 1980s (Shields and Dupuis 2012). Therefore, collection of age, length, and weight data is needed to reestablish the population structure baseline. Genetic samples will provide a genetic baseline to assist in determining eulachon stock structure in Cook Inlet. Finally, incidental observations of marine species may assist in documenting the remaining CIBW PCE species (i.e. Pacific cod, walleye Pollock, saffron cod, and yellowfin sole) utilizing the Lower Susitna River.

7.16.3. Study Area

The eulachon study extends upstream from the mouth of the Susitna River to the uppermost extent of spawning, which will be determined by acoustic surveys.

7.16.4. Study Methods

Eulachon studies will be conducted from May 1 (or ice out) through June 30 (or the end of the eulachon migration) during the 2013 and 2014 field seasons. Sampling will begin at the mouth of the Susitna River one hour prior to high tide. Survey teams will work upriver sampling up to 30 river miles per day or until the uppermost extent of the eulachon spawning distribution is reached. After either RM 90 or the uppermost extent of eulachon spawning is reached (whichever is less), the team will wait at least 24 hours before reinitiating surveying at the mouth.

7.16.4.1. Estimate Eulachon Run Timing and Duration

The primary method employed to collect estimates of eulachon timing and duration will be fixed station dual frequency identification sonar (DIDSON) and an EdgeTech 4125 1600 kHz high-resolution side-scan sonar. DIDSON is a 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 migration. However, to collect good quality images the platform has to 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 (49 feet), the beam array will cover an area that is approximately 23 feet wide.

Sampling will include approximately 10 minutes of DIDSON data and 100 meters (328 feet) of side-scan coverage per sampling event. As we collect more data and develop a better sense of the extent of data needed to determine presence or absence, we may modify the amount of data collected per sample. In the analysis we will provide station ID, location, date, time, eulachon presence/absence, description of fish behavior (i.e., moving in continuous band, discrete schools, milling, spawning).

Acoustics will be synchronized with differential GPS to map the transects and identify the 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).

7.16.4.2. Estimate Eulachon Spawning Site Distribution

Estimation of the distribution of eulachon spawning sites will be based on a combination of pre-determined and adaptive sampling. The pre-determined sampling will be based on what was (and was not) sampled in the 1980s and also take into consideration existing information on depth, velocity, and substrate (ADF&G 1983a, b, 1984). Acoustic surveys will begin at the lowest (i.e., farthest downstream) potential spawning site identified and progress upstream until no spawning eulachon are found. For the adaptive sample component we will follow eulachon upstream until we encounter spawning aggregations and/or add samples where bird activity is observed. Similar to the run timing and duration sample, the spawning site distribution samples will include approximately 10 minutes of DIDSON data and 100 meters (328 feet) of side-scan average.

Sonar transects will be established to the upstream extent of eulachon spawning. Transects will be located to ensure collection of data across representative channel and/or habitat types (e.g. shoreline riffles). Acoustic surveys will begin (Day 1) one hour prior to high tide and extend up river for approximately 30 river miles per day or until the uppermost extent of eulachon spawning is located. Acoustic surveys for the subsequent day (Day 2) will begin where Day 1 ended and continue 30 river miles upstream. This pattern will continue until the uppermost extent of eulachon spawning is located. Once the upper extent of spawning is determined, surveying will cease for 24 hours and then begin at the mouth and continueupstream throughout the spawning season.

Potential spawning sites will be identified in conjunction with the acoustic survey described above. Sites will only be considered spawning sites if all three of the criteria below are met:

1. Fish captured at the site freely expel eggs or milt;
2. Fish are in vigorously free swimming condition; and
3. Twenty or more fish that meet Criteria 1 and 2 are caught in the initial or subsequent site sampling effort (ADF&G 1983c).

Eulachon will be captured either by boat electrofishing or tow net to evaluate their spawning condition.

Sites that meet the spawning criteria will be marked with a GPS unit. The data analysis will provide bounding coordinates of the areas sampled, eulachon presence/absence, fish behavior (i.e., migrating, spawning) and, if possible, a eulachon density estimate (approximate number of fish per unit area times the area occupied). These sites will be compared to the 1980s spawning locations to evaluate changes in spawning locations. These data will assist in assessing whether Project-related changes in stream flow, temperature, etc., may impact the location of suitable eulachon spawning habitat.

7.16.4.3. Estimate Eulachon Density

Acoustics will also be used to determine eulachon density. This is the preferred method for density estimation as it will require minimal handling and disruption of spawning eulachon and will be able to cover large areas on a relatively frequent basis. A two-phase approach will be used to estimate density. During 2013, preliminary data will be collected to determine the feasibility of eulachon density or biomass estimation. Depending on the outcome of the feasibility portion of the study we will attempt to provide a more comprehensive estimate in 2014. Two approaches to explore are to 1) estimate spatial densities on the spawning grounds and delineate the area of the spawning grounds or 2) estimate fish movement over time in areas where eulachon migrate through, rather than spawn.

The sum total of the fish that pass the sonar (biomass) will be collected at each spawning location and fish species verification will be conducted on a subset of spawning locations to estimate the percentage eulachon in the total biomass, which will provide a density estimate. If multiple species are collected, size measurements will be obtained to help differentiate acoustic targets. To verify species for acoustic targets, a variety of fish capture methods will be employed including seining, gill netting, trawling, hand operated dip nets, tow net, and/or boat electrofishing. Different types of sampling gear will be used in different situations; however, an effort will be made to use the same gear as much as possible for comparison. The preferred choices of gear are boat electrofishing with hand operated dip nets or tow net; however, in areas close to shore, beach seining may be more effective. Fish sampling locations will be spread throughout the lower river where sufficient acoustic targets are observed in the acoustic surveys. Total catch by species, area sampled, and measurement of effort (e.g., set times for nets and power, time, and distance for electrofishing) will be recorded for each sampling location.

7.16.4.4. Characterize Eulachon Spawning Habitat

Given that eulachon are a PCE for CIBWs, it is important to identify and characterize the eulachon's spawning habitat to determine potential changes due to the Project. For the acoustic characterization of spawning habitat, we will expand the analysis of the side scan images collected (over 100 x 10 meter sample areas) for the eulachon spawning site distribution portion of the study. Each identified eulachon spawning site will be assigned a unique identifier, GPS coordinates for the upstream and downstream extent, and time will be recorded. Aquatic habitat will be recorded to the meso-habitat level based on the Project habitat classification system (see Section 7.9).

Using acoustics, delineation of areas of substrate types will distinguish cobble, gravel, and sand/silt. The acoustic substrate classification will be compared to a ground truth of physical grab samples. If successful in 2013, the acoustic substrate classification could be expanded in 2014. Ground truthing of substrates will be conducted using an Ekman Bottom Grab Sampler. Systematic substrate samples will be taken. The overall substrate composition will be recorded based on substrate characterization protocols developed for the Project as part of the Instream Flow Study (Section 6.5). The approach will be to record the percent composition for each size category from each sample.

Representative measures of water quality (pH, water temperature [°C], dissolved oxygen in milligrams per liter [mg/L], specific conductance in micro Siemens per centimeter [µS/cm], and turbidity in nephelometric turbidity units [NTU]) and air temperature will be recorded. Water quality will be measured 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. Comparisons will be made within and among sites to identify trends in water quality at spawning habitats.

Water depth at spawning locations will be measured to the nearest tenth-meter with a metric stadia rod, and water velocity will be measured with a velocity flow meter in feet per second. These data will be used to characterize the water depth and velocities needed for eulachon spawning and will be averaged across the runs as well as being reported as ranges. A grid system, similar to that used by Vincent-Lang and Queral (1984) for systematic sampling, may be developed for the collection of water depth and water velocity data . 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 the eulachon are spawning. The size of individual cells within the grid will be determined by the total size of the grid. Water depth and water velocity will be sampled in a subset of cells. Continuous water temperature data measured at water quality monitoring sites (see Section 5.5) and USGS gages will be compared to eulachon spawning habitats. Attempts will be made to correlate water temperature and run timing data to determine if a trend exists. To the extent possible, observers will identify the upstream extent of spawning and will attempt to identify the uppermost extent of eulachon presence.

All data gathered in the spawning habitat identification study will be coordinated with the Instream Flow Study to help determine the relationship between natural flows and existing habitats.

7.16.4.5. Eulachon Population Structure

During each species verification capture, a subset of eulachon will be sampled for fork length, sex, and weight. These data will be used to develop length and weight frequency distributions by sex and run. Each day a subset of eulachon will be collected for age analysis based on otoliths. These data will be used to provide the length and weight distribution with age classes.

These data will be compared with the length, fish weight, and age class data.

The sex ratio will be determined for each survey day. The eulachon that will be sexed during each species verification capture will provide a daily indication of changes in the population structure through time.

7.16.4.6. Collect Genetic Samples for Eulachon Baseline Structure

In support of the ADF&G's development of genetic baselines for various species, genetic samples from a subset of eulachon (approximately 50) will be collected. Samples will be anal fin clips cut from the fish with scissors. While in the field, tissue samples will be preserved in ethyl alcohol in a 125-500 milliliter bulk sample bottle for each location. Upon completion of the collection, the samples will be delivered to the Gene Conservation Laboratory.

7.16.4.7. Incidental Observations of Marine Fish Species

Marine fish species venture into freshwater for limited periods, and some prefer shallow coastal water in and around river mouths (Cohen et al. 1990, Morrow 1980). Marine fish species incidentally caught in the study area during the eulachon study will be identified based on identification keys; any fish in question will be photographed and identified later by a marine species expert. The occurrence of walleye pollock, yellowfin sole, saffron cod, and Pacific cod, all of which are designated as PCE species for CIBWs, will be documented as well. All marine fish will be measured (either fork length or total length to nearest millimeter).

The observers will determine CPUE for all fish species. All information regarding marine fish species presence in the Lower Susitna River will be shared with the Study of Fish Distribution and Abundance in the Middle and Lower Susitna River (Section 7.6).

7.16.5. 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. DIDSON and side-scan sonar have been used by ADF&G for at least five years (Burwen et al. 2007). All data collection efforts will follow State of Alaska guidelines.

7.16.6. Schedule

The study team will apply for ADF&G permits 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) during both years. Data analyses will be completed by the beginning of October of each year, except for the analyses that are outsourced to other laboratories, such as genetics and otoliths. Quality assurance/quality control (QA/QC) on the data analyses will be completed by the middle of October each year. In 2013, the Initial Study Report will be issued in December. The Updated Study Report will be completed by the middle of December 2014.

7.16.7. Level of Effort and Cost

Fieldwork will occur from May 1 or ice out until June 30 or the end of the eulachon run. A team of four will be sampling approximately 30 miles of river a day for days 1- 3. Sampling will not occur on Day 4, and the cycle will repeat for the entire sampling period.

The approximate cost for the eulachon studies is $675,000 for both 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 would decrease.

7.16.8. Literature Cited

Alaska Department of Fish and Game (ADF&G). 1983a. *Susitna Hydro aquatic studies, phase II basic data report.* Volume 4: Aquatic habitat and instream flow studies, 1982, parts I and II.

—. 1983b. *Susitna Hydro aquatic studies, phase II basic data report*. Volume 1: Summarization of volumes 2; 3; 4, parts I and II; and 5.

—. 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.

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. 07-44, 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.

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-easternPacific 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. Aalska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries.

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.

7.17. Cook Inlet Beluga Whale Study

7.17.1. General Description of the Proposed Study

7.17.1.1. Study Goals and Objectives

The goals of this study are to 1) provide current information on Cook Inlet Beluga Whale (*Delphinapterus leucas*; CIBW) distribution and the importance of the Susitna River delta to the CIBW population, and 2) to correlate these data with information on the ecology of CIBW prey species. Information is needed regarding CIBWs and their prey in the Susitna River and delta to assess the potential effects of any changes in the lower river habitat that may result from the construction and operation of the Project. CIBW prey species information (i.e., eulachon and salmon) will be coordinated with fish studies both currently ongoing and those proposed for the lower river (see Sections 7.5, 7.6, 7.7, 7.9, and 7.16). This information will be used by FERC in its NEPA and licensing processes; for the NMFS Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) consultations; and for the development of any necessary protection, mitigation and enhancement (PM&E) measures.

Three objectives have been identified for this study:

1. Document the presence of all marine mammals in the Susitna River delta, focusing on CIBWs distribution within Type 1 critical habitat;
2. Determine marine mammal utilization of the Susitna River, focusing on the upstream extent of CIBWs; and
3. Evaluate the relationships between potential hydropower-related changes in the lower Susitna River, CIBW in-river movements, and CIBW prey availability.

7.17.2. Existing Information and Need for Additional Information

Cook Inlet Beluga Whales reside in Cook Inlet year-round and have been documented spending significant portions of time in Upper Cook Inlet, particularly in late summer and fall (Funk et al. 2005, NMFS 2008, Allen and Angliss 2011). The CIBW was listed as a federally-protected endangered species under the ESA in October 2008 (73 FR 62919). In April 2011, the NMFS published a final rule designating critical habitat for the CIBW (76 FR 20180; Figure 7.17-1). When determining critical habitat, the NMFS identified the following five primary constituent elements (PCEs) essential to the conservation of the Cook Inlet Beluga Whale:

1. Intertidal and subtidal waters of Cook Inlet with depths <30 feet (mean lower low water, MLLW) and within 5 miles of high and medium flow anadromous fish streams;
2. Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye, pollock, saffron cod and yellowfin sole;
3. Waters free of toxins or other agents of a type and amount harmful to Cook Inlet Beluga Whales;

4. Unrestricted passage within or between the critical habitat areas; and
5. Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet Beluga Whales.

Based on these criteria, NMFS identified two specific marine area types in Cook Inlet that contained one or more PCE. Type 1 critical habitat encompasses 1,909 square kilometers (738 square miles) of Cook Inlet northeast of a line from the mouth of Threemile Creek to Point Possession. Type 1 critical habitat has the highest concentrations of beluga whales from spring through fall. Type 2 critical habitat consists of 5,891 square kilometers (2,275 square miles) of less concentrated spring and summer beluga whale use, but known fall and winter use areas. It is located south of Type 1, and includes nearshore areas along the west side of the Inlet and Kachemak Bay on the east side of the lower inlet. Type 1 critical habitat extends into the Susitna River approximately 8.6 nautical miles from mean lower low water (MLLW) and the Susitna Flats portion of upper Cook Inlet appears to be important calving grounds for CIBWs (Huntington 2000). Due to the importance of the Susitna River delta to CIBWs, information regarding the use of the Susitna River delta compared to other high use areas (i.e., Type 1 critical habitat) is vital to understanding CIBW population dynamics.

A variety of studies have been conducted to document CIBW distribution. The NMFS-National Marine Mammal Laboratory has conducted aerial surveys annually since 1993 during June and August, primarily for abundance estimation (NMFS 2008, Hobbs et al. 2011). Additionally, aerial surveys for beluga whales were completed in 1982 and 1983 as part of the original licensing effort (Harza-Ebasco 1985). From 1999 to 2003, researchers applied satellite tags to 15 whales to examine year-round movements of CIBWs. Finally, land- and boat-based surveys focused on movement and residency patterns have been conducted in the Susitna Flats and adjacent areas to characterize distribution and habitat use by individuals and groups of whales (Funk et al. 2005; Prevel-Ramos et al. 2006, Markowitz and McGuire 2007, Markowitz et al. 2007, Nemeth et al. 2007 McGuire et al. 2008, McGuire and Kaplan 2009, McGuire et al. 2009, 2011a, b). Collectively, these surveys have documented large summer aggregations of CIBWs in the Susitna River delta. While the aforementioned studies have provided valuable information regarding CIBW distribution in Cook Inlet, fine-scale information over the entire open-water season throughout Type 1 critical habitat is lacking. These data are needed to effectively assess potential Project-related effects to CIBWs, their critical habitat, and prey availability.

During the NMFS aerial surveys, other marine mammals have been documented in Cook Inlet, particularly harbor seals (*Phoca vitulina*) and harbor porpoise (*Phocoena phocoena*). Harbor seals in Alaska are not classified as strategic or depleted stocks and are not listed as threatened or endangered under the ESA (Allen and Angliss 2012). The most recent population estimate for the Cook Inlet/Shelikof Strait stock is 22,900 (Allen and Angliss 2012). Harbor seals are distributed throughout Cook Inlet with higher concentrations in lower Cook Inlet compared to the upper inlet. However, sightings of harbor seals in the upper inlet have been increasing over the past few years. The most recent aerial survey documented approximately 1,750 harbor seals in the Susitna River delta (NMFS 2011).

Harbor porpoise in Cook Inlet belong to the Gulf of Alaska stock which is not classified as a strategic or depleted stock and is not listed as threatened or endangered under the ESA (Allen and Angliss 2012). The most recent abundance estimate is 31,046 for Gulf of Alaska harbor porpoise. Harbor porpoise have been documented throughout Cook Inlet using both visual and acoustic techniques (NMFS 2011, ADF&G 2009, 2011). While unlikely, resident killer whales (*Orcinus orca*) have also been acoustically detected in upper Cook Inlet (ADF&G 2011).

7.17.3. Study Area

To assess potential Project-related impacts to CIBWs and other marine mammals, it is necessary to determine the spatial and temporal use of the Susitna River delta by marine mammals, particularly CIBWs, compared to other high use areas in Upper Cook Inlet. Therefore, the Project study area consists of CIBW Type 1 Critical Habitat (Figure 7.17-1), with a focus on the Susitna River delta.

7.17.4. Study Methods

7.17.4.1. Document CIBW and other Marine Mammal Presence within the Susitna River Delta

Aerial surveys conducted by the NMFS occur only in June and August; therefore, the distribution of CIBWs throughout the open water season is not well-documented. Fine-scale information on CIBW seasonal distribution, particularly during times coinciding with spawning and migrations of prey species, is needed to evaluate potential project-related impacts to CIBWs, critical habitat, and prey availability. To address this current lack of information, we propose to conduct aerial surveys for CIBWs throughout Type 1 critical habitat during the entire open water season. The survey schedule will consist of seven surveys per year:

- One in late April (or ice-out)
- Two in May
- One in June (in addition to the NMFS survey)
- One in July
- One in September
- One in October

This schedule will allow for increased survey effort during the spawning season of prey species (May and June). The survey schedule is designed to avoid potential interference with the NMFS surveys in June and August. Each survey will be scheduled for two days with up to 16 flight hours to ensure adequate coverage of Type 1 critical habitat and to allow for additional time to circle around areas where CIBWs are encountered. Flights will be conducted at 1,000 feet to avoid disturbance to marine mammals and, by extension, avoid the need for a marine mammal take permit.

To the greatest extent possible, aerial survey protocols will utilize the methodology employed by the NMFS to ensure consistency with data collection and facilitate potential analyses between studies (e.g., Hobbs et al. 2011). The aerial survey team will consist of one pilot, two experienced marine mammal observers (MMOs), and one data recorder. To obtain more accurate sighting rates and correction factors for missed groups, the two MMOs will document CIBW presence independently and will not cue each other to sightings. Surveys will mainly consist of coastal tracklines conducted within 1.5 kilometers (4,921 feet) from shore due to high CIBW concentrations near tidal flats and river mouths. Saw-tooth tracklines performed across the Inlet will be flown to maximize the coverage area and survey variations in habitat. The plane will be equipped and the pilot will fly pre-programmed trackline coordinates with a GPS unit to permit precise trackline fidelity. The preplanned tracklines may be modified based on any weather-related restrictions.

Survey protocol will follow Hobbs et al. (2011) and will generally include the following steps. MMOs will scan the water visually to locate CIBWs via unaided eyes. The data recorder will enter information into a custom data acquisition program on a laptop computer interfaced with an independent GPS. This interface will allow the team to collect data in real-time. For each sighting, the time and position will be captured through the GPS-enabled data program. The recorder will enter the angle of the sighting by direction from the MMO who will use an inclinometer to obtain the degrees relative to the survey aircraft. Data for marine mammals will include location, group size, group composition (i.e., adults, juveniles, and cow-calf pairs), and behavior. Associated animals (e.g., seabirds and fish) and vessel (e.g., commercial and recreational) presence will be recorded. Environmental data will be updated every 30 minutes and for every sighting. Effort data recorded will include effort status (i.e., on-effort, off-effort, or circling), observer positions, and environmental conditions which can affect the observers' ability to sight animals (e.g., high sea state, glare, and sun position).

While all marine mammal sightings will be documented during the aerial surveys, more detailed methods will be used when a group of CIBWs is encountered. Each observer will independently count the number of animals in each group and multiple passes (up to five) may be performed to get the most accurate count of each CIBW group. All counts from both observers will be combined and the median will be used to achieve the most accurate group size and reduce the effect of outliers within counts (Hobbs et al. 2011). When possible, photographs and/or video of CIBW groups will be taken to assist with group counts and group composition. Additionally, the team will report any observations of stranded or distressed marine mammals to the NMFS.

7.17.4.2. Determine the Upstream Extent of CIBWs and other marine mammals in the Susitna River

Seasonal movement and density patterns of CIBWs, as well as site fidelity, appear to be closely linked to prey availability. These patterns coincide with seasonal salmon and eulachon concentrations (Moore et al. 2000). CIBWs have been documented upriver in Cook Inlet tributaries during spring, summer, and fall. Presence of CIBWs is confirmed at numerous rivers, including the McArthur, Beluga, Lewis, Theodore, Ivan, Susitna, and Little Susitna on the west side of Upper Cook Inlet. Historic records indicate that CIBWs have been seen in the eastern channel of the Susitna River as far as 30 to 40 miles upriver, yet are most commonly found within the first 5 miles of the Susitna River delta (Funk et al. 2005). The current utilization and the northern extent within the Susitna River are not well documented.

While aerial surveys are appropriate to document the presence of CIBWs in Upper Cook Inlet and the Susitna River delta, these surveys only represent a short time period (i.e., hours). To increase the ability to detect CIBW presence in the Susitna River, particularly to determine the current northern extent, a combination of live-feed remote video camera systems and still cameras will be utilized. Live-feed cameras can provide real-time data over long time periods (i.e., weeks to months). Remote camera systems also allow for data collection without disturbing study animals and provide details that cannot be obtained through aerial surveys. This technology was successfully used in the Little Susitna River for CIBWs in 2011 by the Alaska Sea Life Center. In addition to documenting CIBWs, this technology was also successful at identifying harbor seals within the river.

Live-feed cameras (up to four) will be established at the mouth of the Susitna River and still cameras (up to four) will be placed up to RM 10. Additional photographic data from cameras installed to monitor ice processes and in-stream flow will be examined for the presence of CIBWs. The video camera system will utilize remotely operated camera technology (see More Wildlife Systems, Homer, AK), which will allow observers to remotely manipulate the cameras (e.g., pan, zoom, capture still images, wipe lens, etc) in real-time via a microwave link. The camera systems will be mounted to 9-meter steel towers embedded in the ground. Batteries, electronics, and the recharging system to run the cameras will be located in hard cases mounted at the base of the steel towers and the live images from the cameras will be transmitted via microwave signal to a receiver.

Observer monitoring shifts will be scheduled to cover up to 7 days a week with a primary focus on high-water periods. Monitoring effort will be targeted around a range of tides with the majority of effort at high tide. Scans of the study area will be conducted every 20 minutes throughout each monitoring shift. For each scan, the observers will position the camera at the farthest south or north position and slowly move the camera through the study area. Camera movement will be incremental, not continuous. With each movement of the camera the observers will pause long enough to determine if whales were present before moving the camera. Scans will last between 10 and 15 minutes, but may be longer if belugas are present to allow for accurate data collection. During intervals between scans, the cameras will be positioned at a single location and checked frequently for opportunistic sightings. The location of the cameras between scans will be positioned towards the area with greatest possibility of having an opportunistic sighting determined by distance from the camera and visibility due to current tidal stage.

Data Collection Overview

The study area will be divided into grids to allow documentation of activity within the camera's field of view. When belugas are present, observers will log group location, size, composition, and behaviors onto data sheets which will be entered into a database. Once a group is sighted observers will continue to follow the group, as time, presence of other beluga groups, and conditions allow, with the goal being to get the most comprehensive data from the study area. For example, observers might follow a group for a shorter period of time before scanning the area for other groups if it was at the beginning of a monitoring shift, since there is less awareness of activity going on in the remainder of the study area.

Behavior Logs

Beluga behavior will be recorded by activity codes onto data sheets that allow the recording of the top three activities of each group. The primary activity will represent the activity of the group as a whole, and will be determined first (e.g., traveling). Secondary and tertiary activities occurring within only a portion of the total group location will also be noted (e.g., tail slapping). If observers are able to obtain close-up video of whales with distinctive markings, still photos of these events will be collected for potential use in photo-identification. Presence and behavior of any other marine mammals or humans (including vessel traffic), will also be recorded, and video of interesting events will be recorded and archived.

Group Counts

Two methods for group counts are possible depending on the level of camera coverage. Scenario One would replicate methods used in 2011 for a similar project in the Little Susitna River. During that study two cameras were used at a single site, but video feed could only been seen from one camera at a time. A group of belugas would be sighted and observed within a scan. As successive surveys were conducted the observer might lose sight of a group as they scanned the complete study area. In order to accurately capture the dynamic movements of whales within the study area without inflating total numbers of whales reported, a two-pronged data collection scheme was implemented. Upon sighting a group of whales for the first time the observer would keep them in view long enough to accurately assess location, composition, and behavior. After recording these data the observer would continue to scan the study area for the presence of other groups of whales. On successive scans, whales sighted were assigned a new group number and a new line of data was recorded, again documenting composition, location, and behavior, and comments made on the data sheet indicating that this was most likely the same group as previously recorded.

Within the database, whale sightings were assigned two identification numbers, a “day group” number reflecting the actual group number recorded on the data sheet and an “archive group” which would remain the same for successive sightings of the same group. For example, a group sighted on four successive scans would be assigned “day group” numbers of 1, 2, 3, and 4 for each scan, but the “archive group” number would remain the same for all four scans. If a single group of whales split into distinct segments, letters were used to denote subgroups of the same parent group (e.g. group 1 split into group 1a, 1b, etc.). Day group numbers were reset at the beginning of each new monitoring day and archive group numbers were assigned consecutively for the duration of the study period. If two distinct groups (group 1 and group 2) merged (group 1 joined group 2) the combined group was given the archive group number of the group that was joined (in this case group 2 archive number).

For reporting purposes, beluga whale “groups” are in reference to archive groups in order to accurately reflect the total number of groups and individuals observed. Beluga whale “sightings” are in reference to behavior, composition, and/or location data recorded within the confines of a single scan (day group) in order to reflect dynamic changes within the study area by a single group.

In Scenario Two, each camera site would have two cameras with the ability for independent operation for each camera, called “paths.” The two paths would allow for concurrent movement of both cameras. With this setup one camera would have a wide angle overview of the study site and could provide broad sweeps over the area to look for other groups while still maintaining the first group in view. The second camera would focus on each group for counts and observations. This would be similar to an on-site human observer that would be able to use peripheral vision to note new activity in the river while doing focal observations on a specific group. The method of tracking and recoding behaviors would remain similar to Scenario One with more accuracy in day group numbers and higher potential to capture travel up river while still collecting focused group information and behaviors.

Data can be accessed in a real-time format as needed for planned activity in the river. Post collection data will be presented in reports monthly that will reflect monitoring effort, beluga activity (presence, group size, location, composition) as well as environmental conditions.

7.17.4.3. Evaluate the Relationship among Potential Hydropower-Related Changes in the Lower River, CIBW In-River Movements, and Prey Availability

Whale movement and habitat use studies employing satellite telemetry and hydrodynamic modeling indicate that CIBW distributions are controlled not only by water temperature and ice coverage, but also by the seasonal flow patterns of various rivers (Goetz et al. 2012). This finding suggests that availability of salmon and other fish (i.e., eulachon) in river mouths influence CIBW movements (Ezer 2011). CIBWs use the Susitna River delta throughout the majority of the open water season (late-April through September; NMFS 2008). The spring timing is coincident with the spawning migrations of eulachon and Pacific salmon into the river. As a result, availability of prey species was one of the PCEs used to designate critical habitat in 2011 (76 FR 20180).

Potential Project-induced effect mechanisms related to CIBWs are anticipated to be limited to indirect effects due to impacts on prey abundance, densities, and/or run timing. Therefore, if significant Project-related impacts to prey are identified during the ongoing and proposed fish studies (Sections 7.5, 7.6, 7.7, 7.9, and 7.16), AEA will collaborate with NMFS to determine the best model to use to estimate effects to CIBWs. CIBWs could be impacted by potential Project-induced changes to sediment transport and delivery, stream temperature, water quality, stream flow, and ice processes. Project- related effects could occur if any such changes prevented, impaired or delayed CIBW access to delta or river habitats that support known prey species, including eulachon and Chinook, sockeye, chum and coho salmon. In addition, Project-related effects could occur if any such changes affect abundance, densities, and/or run timing of these prey species. Data from this study on the distribution of CIBWs will be combined with data from studies investigating potential Project-induced changes to sediment transport and delivery, stream temperature, water quality, and stream flow, as well as modifications in ice processes to assess the potential effects on salmon and eulachon habitat, productivity, abundance, and run timing. Similar modeling efforts have recently been conducted for CIBWs (Goetz et al. 2012).

7.17.5. Consistency with Generally Accepted Scientific Practices

The study methods presented are consistent with methods commonly followed in investigations of marine mammal distribution. To the greatest extent possible, aerial survey protocols will utilize the methodology employed by the NMFS to ensure consistency with data collection and facilitate potential analyses between studies. The proposed method for live-feed remote video cameras has been successfully used to document marine mammal movements and behaviors in large river systems in Alaska.

7.17.6. Schedule

The anticipated field schedule for 2013 and 2014 will run from late April (or ice-out) through the end of October. Each year, seven aerial surveys will be conducted:

- One in late April
- Two in May
- One in June (in addition to the NMFS survey)
- One in July
- One in September

- One in October

This schedule for aerial surveys will allow for increased survey effort during the spawning season of CIBW prey species (two surveys in May and two surveys in June including the NMFS survey). In addition, the survey schedule is designed to avoid potential interference with NMFS surveys in June and August. Remote cameras will be installed in late April and will operate until the end of October. Data analyses will be completed by the beginning of November of each year. Quality assurance/quality control (QA/QC) reviews on the data analyses will be completed by the end of November each year, and reporting will be completed by the middle of December 2013 (Initial Study Report) and 2014 (Updated Study Report).

7.17.7. Level of Effort and Cost

Field work will occur daily from late April through September. Aerial survey teams will consist of four people and up to four observers will be utilized for remote-camera monitoring and data analysis. Each aerial survey is scheduled for 2 days (up to 16 flight hours) for a total of 112 flight hours each year. Approximate yearly cost for aerial surveys is $300,000 and approximate cost for remote-camera equipment and operations is $300,000 per year.

7.17.8. Literature Cited

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

Allen, B.M., and R. P. Angliss. 2010. *Alaska marine mammal stock assessments, 2009*. U.S. Department of Commerce, NOAA Technical Memorandum NMFSAFSC-206. Seattle, Washington: National Marine Fisheries Service.

Allen, B.M., and R. P. Angliss. 2011. *Alaska marine mammal stock assessments, 2010*. U.S. Department of Commerce, NOAA Technical Memorandum NMFSAFSC-223. Anchorage, Alaska: National Marine Fisheries Service.

Ezer, T. 2011. Using inundation modeling and remote sensing data to study hydrodynamic and environmental impacts on the survival of Cook Inlet's Beluga whales. Final Report for the period: 1-October, 2010 to 30-Deptember, 2011. Norfolk, Virginia: Report prepared under Project RFQ# NOAA_NMFS_AKR_10_0802_2G for National Oceanic & Atmospheric Administration by Center for Coastal Physical Oceanography, Old Dominion University.

Funk, D.W., T. M. Markowitz, and R. Rodrigues, eds. 2005. *Baseline studies of beluga whale habitat Use in Knik Arm, Upper Cook Inlet, Alaska, July 2004—July 2005*. Prepared for the Knik Arm Bridge and Toll Authority, Anchorage, AK, the Department of Transportation and Public Facilities, Anchorage, AK, and the Federal Highway Administration, Juneau, Alaska by LGL Alaska Research Associates, Inc., Anchorage, AK, in association with HDR Alaska, Inc., Anchorage, AK,

Goetz, K.T., Rugh, D.J., Read, A.J., and Hobbs, R.C. 2007. Habitat use in a marine ecosystem: beluga whales, *Delphinapterus leucas,* in Cook Inlet, Alaska. *Marine Ecology Progress Series* 330:247-256.

Goetz, K. T., Montgomery, R. A., Ver Hoef, J. M., Hobbs, R. C. and D. S. Johnson. 2012. Identifying essential summer habitat of the endangered beluga whale, *Delphinapterus leucas*, in Cook Inlet, Alaska. *Endangered Species Research* 16:135-147.

Hobbs, R. C., C. L. Sims, and K. E. W Shelden. 2011. Estimated abundance of belugas in Cook Inlet, Alaska, from aerial surveys conducted in June 2011. Unpublished report. National Marine Fisheries Service, National Marine Mammals Laboratory.

Harza-Ebasco Susitna Joint Venture (Harza-Ebasco). 1985. *Fish, wildlife, and botanical resources for the Susitna Hydroelectric Project. Exhibit E, Volume 9*. Prepared for the Alaska Power Authority by the Harza-Ebasco Susitna Joint Venture, Anchorage, Alaska.

Markowitz, T.M., and McGuire, T.L., eds. 2007. *Temporal-spatial distribution, movements and behavior of beluga whales near the Port of Anchorage, Alaska*. Prepared for Integrated Concepts and Research Corporation and the U.S. Department of Transportation Maritime Administration by LGL Alaska Research Associates, Inc., Anchorage, Alaska.

Markowitz, T.M., McGuire, T.L., and Savarese, D.M. 2007. *Monitoring beluga whale (*Delphinapterus leucas*) distribution and movements in Turnagain Arm along the Seward Highway*. Final report prepared for HDR and the Alaska Department of Transportation and Public Facilities by LGL Alaska Research Associates, Inc., Anchorage, Alaska.

McGuire, T.L., and Kaplan, C.C. 2009. *Photo-identification of beluga whales in Upper Cook Inlet, Alaska*. Final report of field activities in 2008. Prepared for National Fish and Wildlife Foundation, Chevron, and ConocoPhillips Alaska, Inc by LGL Alaska Research Associates, Inc., Anchorage, Alaska,

McGuire, T.L., M.K. Blees, and M.L. Bourdon. 2011a. *The development of a catalog of left-side digital images of individually-identified Cook Inlet beluga whales* Delphinapterus leucas. Final Report 910 prepared for the North Pacific Research Board .

—. 2011b. *Photo-identification of beluga whales in Upper Cook Inlet, Alaska*. Final report of field activities and belugas resighted in 2009. Prepared for National Fish and Wildlife Foundation, Chevron, and ConocoPhillips Alaska, Inc. by by LGL Alaska Research Associates, Inc., Anchorage, Alaska.

McGuire, T.L., Kaplan, C.C., and Blees, M.K. 2009. *Photo-identification of beluga whales in Upper Cook Inlet, Alaska*. Final report of belugas resighted in 2008. Prepared for National Fish and Wildlife Foundation, Chevron, and ConocoPhillips Alaska, Inc., by LGL Alaska Research Associates, Inc., Anchorage, Alaska,

McGuire, T.L., Kaplan, C.C., Blees, M.K., and Link, M.R. 2008. *Photo-identification of beluga whales in Upper Cook Inlet, Alaska*. 2007 annual report. Prepared for Chevron, National Fish and Wildlife Foundation, and ConocoPhillips Alaska, Inc. by LGL Alaska Research Associates, Inc., Anchorage, Alaska.

Moore, S.E., K.E.W. Shelden, L.K. Litzky, B.A. Mahoney and D.J. Rugh. 2000. Beluga whale, (*Delphinapterus leucas*), habitat associations in Cook Inlet, Alaska. *Marine Fisheries Review* 62(3):60–80.

Nemeth, M.J., Kaplan, C.C., Prevel-Ramos, A.M., Wade, G.D., Savarese, D.M., and Lyons, C.D. 2007. *Baseline studies of marine fish and mammals in Upper Cook Inlet, April through*

October 2006. Final report prepared for DRven Corporation by LGL Alaska Research Associates, Inc., Anchorage, Alaska.

National Marine Fisheries Service (NMFS). 2008. Endangered and threatened species: endangered status of the Cook Inlet beluga whale; Final Rule. *Federal Register* 73:62919-62930.

Prevel-Ramos, A.M., Markowitz, T.M., Funk, D.W., and Link, M.R. 2006. *Monitoring beluga whales at the Port of Anchorage: Pre-expansion observations, August–November, 2005*. Prepared for Integrated Concepts and Research Corporation, the Port of Anchorage, and the U.S. Department of Transportation Maritime Administration by LGL Alaska Research Associates, Inc., Anchorage, Alaska.

7.17.9. Figures

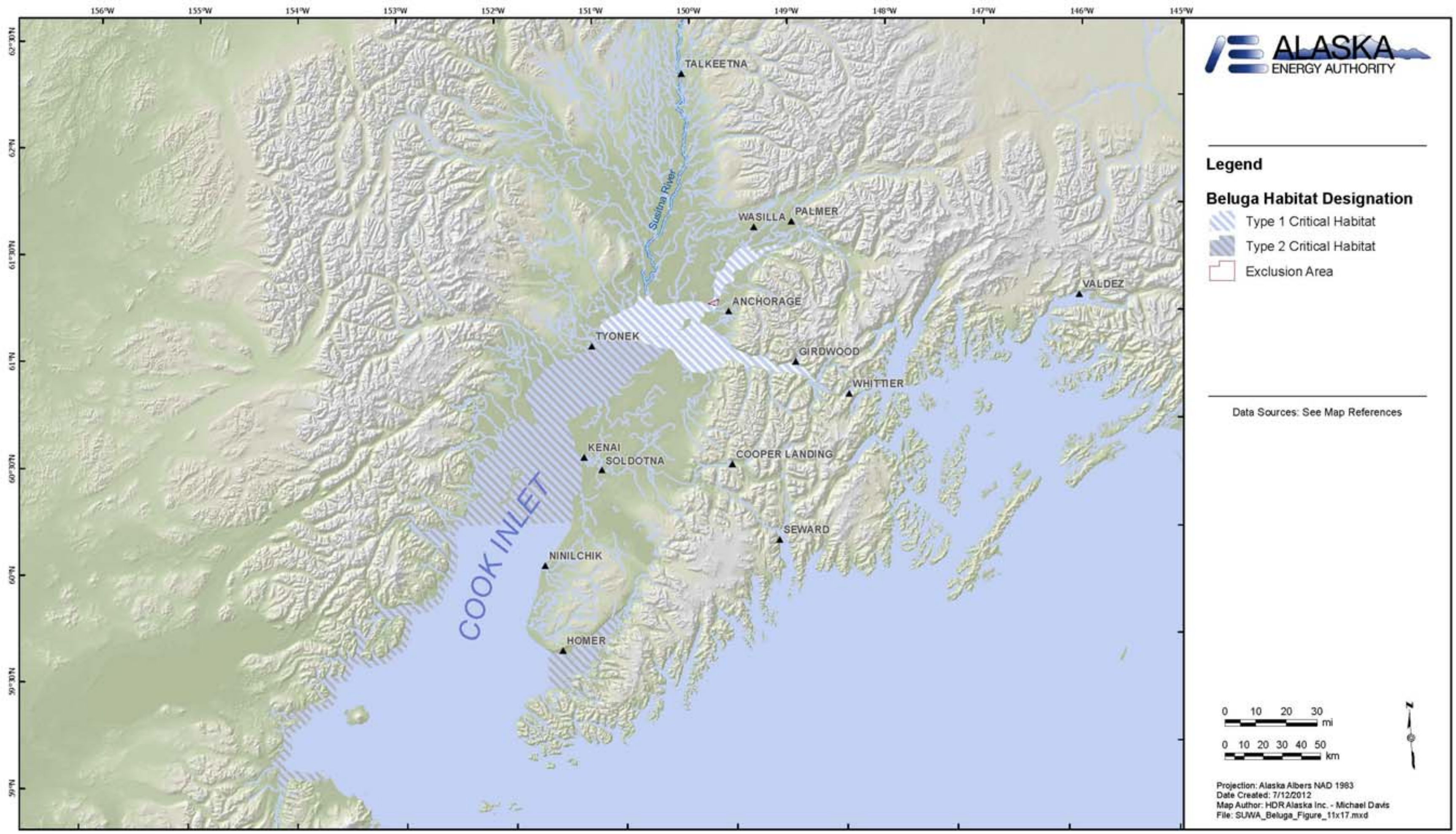


Figure 7.17-1. Designated Critical Habitat for CIBWs.

7.18. Attachments

ATTACHMENT 7-1. DOCUMENTATION OF CONSULTATION ON FISH AND AQUATIC RESOURCES STUDY PLANS

ATTACHMENT 7-1

DOCUMENTATION OF CONSULTATION ON FISH AND AQUATIC RESOURCES STUDY PLANS

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Anchorage Fish and Wildlife Field Office
605 West 4th Avenue, Room G-61
Anchorage, Alaska 99501-2249

IN REPLY REFER TO:
AFWFO

December 30, 2011

Ms. Sara Fisher-Goad
Executive Director
Alaska Energy Authority
813 W Northern Lights Blvd
Anchorage, AK 99503

Re: Proposed 2012 pre-licensing studies for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241-0000

Dear Ms. Fisher-Goad:

The U.S. Fish and Wildlife Service (Service) is responding to the Alaska Energy Authority's (AEA) verbal request for recommendations on pre-licensing studies in 2012 for the Susitna-Watana Hydroelectric Project. The Service has previously provided some verbal comments at project planning meetings and in conversations with AEA project and consulting staff. The Service will be better able to provide complete comments (as part of the National Environmental Policy Act scoping process), after reviewing more thorough descriptions of the proposed project and project operations anticipated in the Preliminary Application Document (PAD). The following comments and study recommendations for 2012 are considered preliminary until we review the PAD and fully understand the scope of the proposed project.

We recognize that the newly proposed Susitna-Watana project is different than the proposed Su-hydro project of the 1980s. Differences in: 1) the two proposed project designs; 2) the past and present study methodologies (due to evolving scientific technologies); and 3) the scientific rigor of previous investigations, may limit the applicability of study results from the 1980s. In many instances, the 1980s studies were limited in spatial and temporal scope, and the methodologies may have been limited, outdated, non-replicable, or lacking in resolution, potentially making them incomparable to present technologies. For these reasons, the Service is concerned about the applicability of the 1980s Su-hydro studies relative to the proposed Susitna-Watana project.

The Service appreciates that AEA recently had the 1980s studies synthesized for identification of data gaps. A reasonable next step is to review the study results for appropriateness and applicability to the newly proposed Susitna-Watana project. Specifically, results from the 1980s studies should be reviewed for statistical validity.

The Service and other resource agencies have previously expressed concerns about the assumptions, relevance, and applicability of 30-year old studies conducted for a different project proposal, in a dynamic basin such as the Susitna River. We have also raised concerns over the lack of proposed studies in the upper and lower reaches (as defined by AEA) of the Susitna River for both the 1980s and in the proposed Susitna-Watana project.

To begin assessing potential impacts to fish and wildlife resources in the project area, the Service recommends the following reconnaissance level studies and reviews for 2012:

- Biometric review of biologic and hydrologic study results from the 1980s.
  Rationale: To assess the statistical validity of the 1980s Su-hydro study results for applicability to proposed studies for the Susitna-Watana project.

- Establish cross-sections for the lower reach, determine the hydraulic connection between the Susitna River and sloughs and off-channel habitats, and incorporate them into the hydrologic model.
  Rationale: To quantify and evaluate the effect of project operations on the lower reach (as climate and other conditions change within the watershed)

- Monitor flow and sediment in the Chulitna and Talkeetna Rivers, and in Gold Creek.
  Rationale: To quantify and evaluate individual tributary flow contributions and sediment loads and assess the potential effect of project operations on lower reach habitats and functions.

- Quantify distribution of fish assemblages relative to available habitat and stream temperature at channel, reach, and spatial scales (as defined by Torgersen et al. 1999).
  Rationale: To assess and quantify fish assemblages relative to available habitats that may be affected by proposed project operations; there are approximately 20 fish species in the Susitna River and little information known about their distribution.

- Collect longitudinal thermal imaging data in all Susitna River study reaches
  Rationale: Information is needed to assess and quantify important aquatic habitats (e.g., thermal refugia) that may be affected by proposed project operations

The Service considers these minimum recommendations necessary to establish a framework to identify future applicable studies throughout the licensing process. When we review the PAD we will likely revise our recommendations to reflect the integration we would like to see in the 2012 studies.

Thank you for the opportunity to provide comments on pre-licensing studies for this proposed project. We look forward to continued coordination with AEA regarding resource appropriate studies. If you have any questions regarding these comments, please contact project biologist, Mike Buntjer at (907) 271-3053, or by email at michael_buntjer@fws.gov.

Sincerely,

Acting For:

Ann G. Rappoport
Field Supervisor

cc: S. Walker, NOAA, susan.walker@noaa.gov
E. Rothwell, NOAA, eric.rothwell@noaa.gov
T. Meyer, NOAA, tom.meyer@noaa.gov
E. Waters, BLM, ewaters@ak.blm.gov
B. Maclean, BLM, bmaclean@blm.gov
C. Thomas, NPS, cassie_thomas@nps.gov
M. LaCroix, EPA, LaCroix.Matthew@epamail.epa.gov
J. Klein, ADF&G, joe.klein@alaska.gov
M. Daigneault, ADF&G, michael.daigneault@alaska.gov
G. Prokosch, ADNR, gary.prokosch@alaska.gov
D. Meyer, USGS, dfmeyer@usgs.gov
K. Lord, DOI, ken.lord@exchange.sol.doi.gov
B. McGregor, AEA, bmcgregor@aidea.org
W. Dyok, AEA, wdyok@aidea.org
B. Long, issues320@hotmail.com
C. Smith, TNC, corinne_smith@TNC.ORG
J. Konigsberg, HRC, jan@hydroreform.org
K. Strailey, ACE, kaarle@akcenter.org
M. Coumbe, ACA, mike@akvoice.org
P. Lavin, NWF, lavin@nwf.org
R. Wilson, Alaska Ratepayers, richwilsonak@gmail.com

References:

Draft Susitna-Watana Hydroelectric Project Aquatic Resources Data Gap Analysis. 2011. Prepared for the Alaska Energy Authority. Prepared by HDR Alaska, Inc., Anchorage, AK.

Grant G. E., J. C. Schmidt, S. L. Lewis. 2003. A geological framework for interpreting downstream effects of dams on rivers. Water science and application 7.

Fausch, K. D., C. E. Torgersen. C. V. Baxter. H. W. Li. 2002. Landscapes to Riverscapes: Bridging the Gap between research and conservation of stream fishes. American Institute of Biological Sciences.

Schlosser, I. J. 1991. Stream Fish Ecology: A Landscape Perspective. BioScience Vol. 41 No. 10
Torgersen, C. E., C.V. Baxter, H. W. Li, and B. A. McIntosh. 2006. Landscape influences on longitudinal patterns of river fishes: spatially continuous analysis of fish-habitat relationships. American Fisheries Society Symposium 48: 473-492.

Torgersen, C. E., R. N. Faux, B. A. McIntosh, N. J. Poage, D. J. Norton. 2001. Airborne thermal remote sensing for water temperature assessment in rivers and streams. Remote Sensing of Environment 76; 386-398.

Torgersen. C. E., D. M. Price, H. W. Li, and B. A. McIntosh. 1999. Multi-scale thermal refugia and stream habitat associations of Chinook salmon in Northeastern Oregon. Ecological Applications 9(1), pp. 301-319.

Water Quality and Sediment Data Gap Analysis. 2011. Prepared for the Alaska Energy Authority. Prepared by URS, Tetra Tech, Inc., and Arctic Hydrologic Consultants, Anchorage, AK.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Anchorage Fish and Wildlife Field Office
605 West 4th Avenue, Room G-61
Anchorage, Alaska 99501-2249

IN REPLY REFER TO:
AFWFO

February 10, 2012

Ms. Sara Fisher-Goad
Executive Director
Alaska Energy Authority
813 W Northern Lights Blvd
Anchorage, AK 99503

Re: 2012 pre-licensing draft study plans for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241-0000

Dear Ms. Fisher-Goad:

The U.S. Fish and Wildlife Service (Service) is responding to the Alaska Energy Authority's (AEA) request for comments on 2012 pre-licensing draft study plans for the Susitna-Watana Hydroelectric Project. The Service provided some initial comments on the draft study plans during the work group meetings January 24-26, 2012, and had anticipated providing additional comments after receiving revised and more thorough descriptions of the proposed studies. Since that meeting, we have conducted an initial review of the Instream Flow, Aquatic Resource, Water Resource, and Eagle and Raptor Nest draft 2012 study plans provided at the January 24-26, 2012, meetings. Due to the short turnaround time requested for feedback (11 business days) on the study plans and their ongoing evolution, our comments should be consider cursory. The following represents our overall issues and concerns with the study plans and the enclosure provides a more detailed accounting of our comments and recommendations for each specific study plan.

Expanded Study Framework and Timeframe: The Service and other resource agencies have frequently expressed concerns about the limited temporal and spatial scale, and limited timeframe, for proposed studies in a dynamic basin such as the Susitna River. We have also raised concerns over the lack of proposed studies in the lower reaches (as defined by AEA) of the Susitna River for the proposed Susitna-Watana project. As part of the hierarchical framework, an ecologically meaningful space-timing scale should be identified related to project studies. As the spatial scale of studies increases, the time scale of important processes such as ice, sedimentation, and channel formation also increases, because they operate at slower rates, time lags increase, and indirect effects become increasingly important. Studies related to these dynamic fish habitat forming processes need to be adequate (i.e., 5 years or more) to begin to understand mechanistic linkages (Wiens et al 1986; Wiens 2007). For this purpose, the Service recommends conducting fish habitat forming process studies on the minimum temporal scale of 5 years. This temporal scale equates to the typical life cycle of Chinook salmon, an Alaska Department of Fish and Game designated stock of concern.

To address these concerns, the Service expects that the 2012 studies and future project-related studies will be conducted on a hierarchical framework (Urban et al 1987; Frissell et al 1986) at a variety of scales including meso-habitat, reach, and basin wide. The Service also expects that the 2012 studies will not only help fill data gaps identified in the Preliminary Application Document (PAD), but will also be integrated between each other and with future project-related studies. This framework and integration is necessary to understand existing conditions and predicted changes to fish habitat in relation to changes in physical processes from proposed regulated flows. We recommend you establish a schedule for analysis of data obtained in 2012 and a framework for how to incorporate the 2012 data into 2013-2014 study plans. This is necessary for resource agencies to adequately assess potential project impacts to Alaska's fish and wildlife resources.

Winter Flow Regimes: At the January 24-26 work group meetings, and in the PAD, winter operations were described as load-following with flows ranging from 3,000 to 10,000 cfs in a 24-hour period. Regulated flows, including load-following operation, result in substantial changes to the natural hydrograph of a river. Dam construction and operation globally has resulted in adverse effects to anadromous and resident fish, macroinvertebrates, and their habitats. The Service is particularly concerned with the lack of study focus on Susitna River winter flows under natural and proposed flow operations. We recommend that winter base flows be assessed beginning in 2012 under the Instream Flow 2012 Study Planning, Water Resources Study Planning, and in the Aquatic Resources Study Planning. During colder winter months, glacial river base flows, such as those in the Susitna River, are derived entirely from groundwater inputs resulting in reduced habitat availability. We recommend assessing base flows as they relate to mainstem winter habitats (including adult spawning and juvenile fish overwintering locations, and the potential for stranding or increased mortality or condition related to changes in flow and water temperature), water quality conditions, ice-processes, and habitat and geomorphic processes in the Susitna River under current conditions and underthe proposed operation.

Temperature: In our December 30, 2011, letter we recommended thermal imagery (Torgerson et al. 1999) be conducted in 2012 throughout the Susitna River mainstem to identify important thermal habitats that may be utilized for spawning, refugia, or as overwintering areas. It is important to characterize the Susitna River water temperature profile as it relates to habitat because the proposed dam is expected to significantly alter the water temperatures downstream of the dam. Please review this letter as a reference for this study, as well as other Service recommendations.

Modeling Design: There is currently a lack of information in the draft study plans related to overall modeling approaches that will be used for the Susitna-Watana project. When identifying instream flow model(s) the purpose and assumptions must be compared to Water Resources and Aquatic Resources study objectives. Model assumptions and model inputs need to be clearly stated and available for review. Spatial pattern should be one of the independent variables in the model analysis. At a minimum, we recommend using 2D hydrodynamic model(s) at a mesohabitat, reach, and basin wide scale (Crowder and Diplas 2000). We specifically recommend a 2D model be included to predict physical processes to spatially represent variation in input variables, and how those variables change temporally and spatially under differing flows. Selected model(s) should also include a sensitivity analysis (Turner et al. 2001). This information is critical to the general project understanding of existing ecological spatial patterns, and predicted spatial patterns under proposed regulated flows from the Susitna-Watana dam.

Mercury: Since the January meetings, it was brought to our attention that fish mercury concentrations frequently increase after impoundment of a reservoir, particularly boreal reservoirs. Soil flooding releases organic matter and nutrients, providing food to bacterial communities that methylate inorganic mercury. Methylation and bioaccumulation are the primary pathways for mercury accumulation in fish (Therriault, 1998). Although not identified in the 2012 draft studies, future studies should include pre- and post-impoundment mercury concentration studies.

Thank you for the opportunity to provide comments on the 2012 draft study plans for this proposed project. We look forward to continued coordination with AEA regarding resource appropriate studies. If you have any questions regarding these comments, please contact project biologist, Mike Buntjer at (907) 271-3053, or by email at michael_buntjer@fws.gov.

Sincerely,

Ann G. Rappoport
Field Supervisor

cc: S. Walker, NOAA, susan.walker@noaa.gov
E. Rothwell, NOAA, eric.rothwell@noaa.gov
T. Meyer, NOAA, tom.meyer@noaa.gov
E. Waters, BLM, ewaters@ak.blm.gov
B. Maclean, BLM, bmaclean@blm.gov
C. Thomas, NPS, cassie_thomas@nps.gov
M. LaCroix, EPA, LaCroix.Matthew@epamail.epa.gov
J. Klein, ADF&G, joe.klein@alaska.gov
M. Daigneault, ADF&G, michael.daigneault@alaska.gov
G. Prokosch, ADNR, gary.prokosch@alaska.gov
D. Meyer, USGS, dfmeyer@usgs.gov
K. Lord, DOI, ken.lord@exchange.sol.doi.gov

B. McGregor, AEA, bmcgregor@aidea.org
W. Dyok, AEA, wdyok@aidea.org
B. Long, issues320@hotmail.com
C. Smith, TNC, corinne_smith@TNC.ORG
J. Konigsberg, HRC, jan@hydroreform.org
L. Yanes, ACE, louisa@akcenter.org
A. Moderow, ACA, andy@akvoice.org
P. Lavin, NWF, lavin@nwf.org
R. Wilson, Alaska Ratepayers, richwilsonak@gmail.com

References:

Crowder, D.W. and P. Diplas. 2000. Using two-dimensional hydrodynamic models at scales of ecological importance. Journal of Hydrology 230:172-191.

Frissell, C A., W. J. Liss, C. E. Warren, and M. D. Hurley. 1986. A hierarchical framework for stream habitat classification; viewing steams in a watershed context. Environmental Management 10: 199-214.

Therriault, T.W., D.C. Schneider. 1998. Predicting change in fish mercury concentrations following reservoir impoundment. Environmental Pollution 101: 33-42.

Torgersen. C. E., D. M. Price, H. W. Li, and B. A. McIntosh. 1999. Multi-scale thermal refugia and stream habitat associations of Chinook salmon in Northeastern Oregon. Ecological Applications 9(1), pp. 301-319.

Turner, M.G., R.H. Gardner, and R.V. O'Neill. 2001. Landscape Ecology in Theory and Practice. Springer-Verlag, New York. Chapter 3, Introduction to Models.

Urban, D. L. R. V. O'Neill, and H. H. Shugart, Jr. 1987. Landscape Ecology.

Wiens, J. A. 2007. Spatial Scaling in Ecology. Functional Ecology, Volume 3, Number 4. (1989), pp. 385-397.

Wiens, J. A., Addicott, J. F., T. J. Case, and J. Diamond. 1986. Community Ecology. Overview: The importance of spatial and temporal scale in ecological investigations.

Enclosure

The following comments and recommendations are based on our review of the 2012 pre-licensing draft study plans for the Susitna-Watana Hydroelectric Project provided at the January 24-26, 2012, work group meetings.

Synthesis of Existing Fish Population Data (F-S1)

Recommend including information on seasonal distribution and abundance of anadromous and resident fish species among riverine habitat types and river reaches. As part of the spawning and incubation period for resident and anadromous species, studies need to include fry emergence periods and time (of day) information to determine potential impacts from fluctuating winter/spring flows. Potential issues include stranding of fish (by life stage and species) and downstream displacement relative to potential ramp rates. This study needs to integrate with instream flow and geomorphic studies to look at effects of daily flow fluctuations, particularly in winter, in the middle and lower river reaches.

For clarity, we recommend referring to river "reaches" as defined in the PAD rather than river "segments."

Fish persistence should be evaluated relative to spatial and temporal availability of fish habitat under existing and proposed flows. The Service recommends fish habitat studies be developed concurrent with the water resource studies to interface and characterize fish habitat as it relates to physical (hydrologic, sedimentation, and geomorphic) processes. Fish habitat metrics should be developed and integrated with modeling efforts related to physical processes and fish presence.

Chinook Salmon Presence above Devil's Canyon Study (F-S4)

Chinook salmon presence above Devil's Canyon study should include an upstream and downstream fish passage component. This 2012 study should include fish passage relative to all life stages of Chinook salmon. There is the potential to include Dolly Varden and Humpback whitefish pending results of an otolith/anadromy analysis by the Service for these species.

The Service supports the genetic component of the study (F-S4) which is necessary to determine whether the Chinook salmon meta-population in the vicinity of the proposed dam is a distinct population.

Wetland Mapping Study (B-S3)

The draft wetland study states that the methods used will be consistent with guidance in the Alaska Regional Supplement (USACE 2007), the U.S. Army Corps of Engineers (USACE) Manual (Environmental Laboratory 1987), and Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979). Therefore, the Service recommends the use of the Cook Inlet Classification (CIC) developed by Mike Gracz. The CIC is an HGM-based wetland ecosystem classification scheme analogous to Cowardin. The Service supports the use of CIC for wetland mapping in the Cook Inlet Basin over Cowardin because CIC is regionally specific and indicative of function (e.g., a spring fen always receives groundwater discharge; whether a palustrine emergent wetland does is unknown). CIC can be cross-walked with Cowardin if necessary. CIC methodologies and Mike Gracz' mapping protocols are described on www.cookinletwetlands.info.

In terms of compensatory mitigation related to a site that will be monitored over time using site-specific, precise functional attribution, the best functional assessment method available is the use of the HGM Regional Guidebooks. The citation for slope/flat wetlands is as follows:

- Hall, J.V., J. Powell, S. Carrick, T. Rockwell, G.G. Hollands, T. Walter and J. White. 2003. Wetland Functional Assessment Guidebook, Operational draft guidebook for assessing the functions of slope/flat wetland complexes in the Cook Inlet Basin Ecoregion, Alaska, using the HGM approach. State of Alaska, Department of Environmental Conservation, Juneau, Alaska.

Eagles and Raptor Nest Study (W-S3)

The Service's Migratory Bird branch is evaluating the potential for an eagle study that would compare productivity/behavior of golden eagles in disturbed areas (such as the Golden Valley Wind project, Usibelli Coal Mine, and the Susitna-Watana dam) versus undisturbed areas (Denali Park). We would like to explore the option of partnering with Watana projects to complete eagle nesting surveys. The Service could potentially provide experienced biologists to conduct the surveys. The benefits to this partnership include: 1) assistance to the project sponsors to conduct an eagle nesting survey; 2) provide cost savings to project sponsors by eliminating the need to hire a consultant to complete the survey; and 3) allow the Service to collect information valuable for our study. These surveys would not be considered compensatory mitigation, but would help meet eagle nest survey requirements. The Service generally recommends a pre-project survey with a follow-up survey just prior to construction.

Since 2009, compensatory mitigation is required for "take" or disturbance of active and inactive bald eagle nests. For golden eagles, there is a "no net loss" policy. Identifying ways to offset compensatory mitigation requirements early in the project development process can help the resource and the project sponsors. For example, a 2-year pre-construction eagle tracking study could help minimize required compensatory mitigation if the study demonstrated a "disturbance" rather than a "loss of territory."

Riparian (B-S2)

In addition to comments provided previously, we recommend riparian studies be integrated with other 2012 studies and with future project-related studies.

Beluga Prey Species Study (F-S6)

This study should identify components that specifically interface with the water resource and fish habitat studies. Anadromous prey species such as eulachon, Pacific and Arctic lamprey have been documented as present in the lower reach of the Susitna River and may be impacted by the proposed regulated flows. Relationships between natural flows and existing habitats should be developed to best predict changes during proposed regulated flows that may impact beluga whale prey species.

Instream Flow Planning Study (F-S5)

1) Selection of a model or series of models of 1D or 2D nature will drive the type of data needs for the field studies. This discussion and selection must be made prior to finalizing habitat studies.
2) The habitat suitability curve development is a useful product. Conduct the studies in such a manner as to ensure the development uses actual suitability data and is not dominated by best professional consensus.
3) Need a better understanding of how the instream flow study relates to the routing model or uses its own calibrated flow model. Concern is that the overall routing model may have significant variation in water level between cross-sections depending on their placement in relation to the habitat cross-sections. Location in pools or riffles and within these features or braided section will vary the water level of a certain flow and may not correctly interpret the water level of a habitat cross-section.
4) Anticipate that the habitat study will have its own cross-sections and flow analysis separate from the routing model. Realize that some selected locations may not be adequate once fieldwork is performed so flexibility is needed to select new spots as needed for 2013 and 2014.
5) Desire to have a large map with the routing and habitat cross-sections on it over recent aerial imagery.
6) In review of 1980s studies, were there any groundwater/surface water exchange studies?
7) Need to confirm whether the 1980s studies included mapping of groundwater upwelling areas along the river for gaining and losing reaches. We recommend at least a large-scale thermal temperature study along the river to note locations and relate it to the habitat study areas and cross-section surveys.

Reservoir and Flow Routing Model Transect Data Collection (WR-S1)

1) We recommend that the cross-section re-surveys in 2012 go beyond the forest limit but stay within the floodprone area, as there may be key floodplain elements not captured in the LIDAR data.
2) Need to evaluate appropriate model to consider ice effects as ice is a significant factor, not only for habitat but also for recreational use. We highly recommend utilizing one model that is fully dynamic and can deal with both floods and ice dynamics during winter low flows for routing. A model was recommended in the January work group discussion, created in Canada that may be appropriate. Model selection will drive data needs so this needs to be selected soon and with a full idea of the types of available models out there to select the best one.
3) Given the discussion of ice dynamics, cross-sections are likely needed in the lower reach to adequately assess ice dynamics as ice forms and slowly freezes upstream. We recommend that these cross-sections be identified and obtained in 2012 to maximize utilization of the model and potentially correlated to lower river habitat studies to reduce redundancy of effort.

4) Instream flow and habitat study cross-sections are assumed to be different than the routing cross-sections. We recommend creating a map for distribution that overlays the original routing and habitat cross-sections to begin to understand their spatial location and orientation and begin discussing 2012 study locations. Realize that some selected locations may not be adequate once fieldwork is performed so flexibility is needed to select new sampling locations as needed for 2013 and 2014.
5) Flows need to be measured to calibrate routing as much as possible. We recommend that water surface and flow be captured at key cross-sections while in the field to calibrate the routing model results and to verify Manning's n assumptions.

Determine Bedload and Suspended Sediment Load by Size Fraction at Tsusena Creek, Gold Creek, and Sunshine Gage Stations (G-S1)

1) For locations obtaining bedload data need to also do a bed pebble count to compare to transported load to calibrate for shear stress and other calculations.
2) Recommend that gravel bar sampling be part of the study to compare to transport load data obtained. This methodology must be well documented.
3) Evaluate the Chulitna and Talkeetna as well as other key tributary deltas for sediment distribution and load into the system.
4) Recommend attempting to get high flow values near bankfull stage at both Gold Creek and Watana sites to add to data.
5) Recommend sediment sampling at the Susitna-Watana dam site to demonstrate correlation to Gold Creek and/or model changes in sediment loading between the sites.
6) Evaluate 3-inch versus 6-inch bedload sampler use for 2012 field season to try to capture large fractions of bedload movement as able.

Geomorphic Assessment of Middle River Reach using Aerial Photography (G-S2)

1) Include a listing and evaluation of flood and ice conditions during and between aerial photography events, especially during breakup periods to help correlate differences to significant events in the watershed.
2) Does not address winter flows and habitat use under winter conditions; needs to come up with a plan to address this beginning winter 2012/13.
3) For geomorphic analysis and comparison to habitat studies, cross-section locations for substrate classification, large woody debris counts in floodprone width, and categorization of fluvial process (Montgomery and Buffington, Rosgen) should be determined and fieldwork performed. If location agrees with an old cross-section, it will help verify any changes over time and with flow to help determine stability and shear stress equations.

Geomorphic Assessment of Project Effects on Lower River Channel (G-S4)

1) There is a need to evaluate the hydrology and habitat use of the lower river to evaluate change over time from dam operations:
   a. Winter operations are a major concern given the need to evaluate daily flow fluctuations of 3,000-10,000 cfs in the winter. This effect must be modeled into

the lower reach to see if the magnitude of fluctuating flows in the winter extends further downstream than spring and summer flow periods. Additionally, ice and open water effects will be extended into the downstream area so modeling will need to address this by extending it downstream.

b. In the January work group meetings it was pointed out that ice is generated upstream and flows down the river to the lower reaches, beginning to form in the lower reach and slowly ice up the river upstream. This also needs modeling from a thermal standpoint, hence again, the need for cross-sections in the lower reaches.
c. Recommend that the gage at Su Station be turned on by the U.S. Geological Survey (USGS) and maintained by USGS to help calibrate lower reach modeling efforts over the next 5 years, especially for ice effects and dynamics modeling.
d. Cross-sections need to be made in the lower reach to add to an ice dynamics model as well as habitat studies – recommend selecting locations and getting these cross-sections in 2012 to facilitate modeling efforts.

2) Re-do all cross-sections at existing and past gage sites in the middle and lower reaches (including Su Station) to evaluate hydraulics, assess stability by comparing to old cross-section data and give an initial assessment of stability or changes in rating curve information. Also, it would be beneficial to do an initial evaluation of these gage sites at winter flows and with ice dynamics to begin to understand the impact winter flows will have. This will help with evaluating changes over the last 30 years in the lower reaches to determine whether additional work in 2013-2014 is needed.

Documentation of Sustina River Ice Breakup and Formation (G-S3)

1) Key elements to identify are: where ice generation occurs (production zones) and where ice lodges and begins the process of ice formation in the river.
2) Recommend that flights include an ice scientist, fishery biologist, riparian specialist and fluvial geomorphologist so that multiple observations can be made at the same time and can be stitched together to understand the processes taking place.
3) Recommend video be taken during all river flights for later reference.
4) Documentation of frazil ice generation is very important – current thought is that 80% is generated upstream of Devil's Canyon in the middle reach.
5) Daily flights might be needed during the height of breakup or freeze-up.
6) Is CRREL involved with the ice research?
7) Highly recommend utilizing our Canadian neighbors and their research and models for ice issues.

Review of Existing Water Temperature Data and Models (WQ-S1)

1) Identify appropriate temperature models to use based on new technology and understanding.
2) Evaluate MET station locations and strongly consider an additional station around the Deshka or Yentna which could help with ice studies.

3) Discuss MET station locations with NOAA Weather Forecast Center to access experts as well as potentially help with storing data.
4) Perform large-scale thermal study of the river for groundwater exchange areas over different flows.
5) At old, existing, and new gage sites, include continuous temperature monitoring; consider a water quality study at gage sites for 2012, 2013, and 2014 seasons with parameters agreed to by all parties and performed by USGS.
6) Evaluate past assumptions for temperature modeling (at least our understanding of it), i.e., summer analysis of surface water temperatures only, as this dominates habitat use, versus winter analysis of intergravel temperature only. Provide quantification of the hypothesis and assumptions made and determine if they are still relevant.
7) 2012 fieldwork in the work group meeting was discussed to primarily show how mainstem temperatures influence side channel habitat. This should be expanded to do a thermal analysis up and down the river (#4).
8) Discussed in the work group meetings that 2013-2014 work will deal with upwelling water temperatures. A thermal analysis in 2012 can help determine these sites.
9) Fieldwork needs to be performed that can help calibrate heat transfer coefficients and other assumptions in selected temperature models between mainstem and other waters.
10) Analysis of temperature effects on ice formation was not discussed and needs to be part of the scope in coordination with ice and habitat studies.
11) Ensure that solar radiation information will be collected at all MET sites as it is crucial to modeling efforts (ice, etc.) and evaluate other metrics that are needed for calibrating models.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Anchorage Fish and Wildlife Field Office
605 West 4th Avenue, Room G-61
Anchorage, Alaska 99501-2249

IN REPLY REFER TO:
AFWFO

February 21, 2012

Ms. Sara Fisher-Goad
Executive Director
Alaska Energy Authority
813 W Northern Lights Blvd
Anchorage, AK 99503

Re: Comments on an additional 2012 draft study plan for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241-0000

Dear Ms. Fisher-Goad:

The U.S. Fish and Wildlife Service (Service) is responding to the Alaska Energy Authority's (AEA) request for comments on 2012 pre-licensing draft study plans for the Susitna-Watana Hydroelectric Project. The Service provided initial comments on the draft study plans during the work group meetings January 24-26, 2012, and provided additional comments in our February 10, 2012, letter. The following comments and recommendations are based on our review of an additional draft study plan for the Susitna-Watana Hydroelectric Project provided in the Request for Proposals we received February 8, 2012. As in our February 10, 2012, letter, because of the short turnaround time requested for comments on the study plans and their ongoing evolution, our comments should be considered cursory.

Adult Salmon Distribution and Habitat Utilization (F-S3): The study objectives include characterizing the spawning habitat utilization of turbid mainstem and side channel habitats by adult anadromous species as well as the spawning habitat utilization in clear water side sloughs and upland sloughs. However, the methods only mention surveys in the Middle Reach (RM 98 to 150). We recommend that study methods be expanded to ensure characterization of spawning habitat utilization in the lower river reaches of the river as well to allow for a more comprehensive assessment of potential impacts of the project on salmon spawning habitats throughout the length of the Susitna River. In addition, we recommend that this study be fully integrated with instream flow and geomorphic studies to assess the effects of daily flow fluctuations, particularly in fall and winter.

Thank you for the opportunity to provide comments on the 2012 draft study plans for this proposed project. We look forward to continued coordination with AEA regarding resource appropriate studies. If you have any questions regarding these comments, please contact project biologist, Mike Buntjer at (907) 271-3053, or by email at michael_buntjer@fws.gov.

Sincerely,

Ann G. Rappoport
Field Supervisor

cc: S. Walker, NOAA, susan.walker@noaa.gov
E. Rothwell, NOAA, eric.rothwell@noaa.gov
T. Meyer, NOAA, tom.gcak.meyer@noaa.gov
E. Waters, BLM, ewaters@blm.gov
B. Maclean, BLM, bmaclean@blm.gov
C. Thomas, NPS, cassie_thomas@nps.gov
M. LaCroix, EPA, LaCroix.Matthew@epamail.epa.gov
J. Klein, ADF&G, joe.klein@alaska.gov
M. Daigneault, ADF&G, michael.daigneault@alaska.gov
G. Prokosch, ADNR, gary.prokosch@alaska.gov
D. Meyer, USGS, dfmeyer@usgs.gov
K. Lord, DOI, ken.lord@exchange.sol.doi.gov
B. McGregor, AEA, bmcgregor@aidea.org
W. Dyok, AEA, wdyok@aidea.org
B. Long, issues320@hotmail.com
C. Smith, TNC, corinne_smith@TNC.ORG
J. Konigsberg, HRC, jan@hydroreform.org
L. Yanes, ACE, louisa@akcenter.org
A. Moderow, ACA, andy@akvoice.org
P. Lavin, NWF, lavin@nwf.org
R. Wilson, Alaska Ratepayers, richwilsonak@gmail.com

SUSITNA-WATANA INSTREAM FLOW STUDY (SWIFS)
Teleconference Meeting Minutes
March 15, 2012

Project: Susitna-Watana Instream Flow Study
FERC No. 14241

Meeting Date: March 7, 2012 (3-5 PM AST)

Location: Via Teleconference

Participants: Joe Klein (ADFG), Mike Buntjer (USFWS), Betsy McCracken (USFWS), Susan Walker (NMFS), Bob Henszey (USFWS), Betsy McGregor (AEA), Craig Addley (Cardno-Entrix), Steve Padula (Longview), Dudley Reiser (R2), Paul DeVries (R2), Stuart Beck (R2), Kevin Fetherston (R2), Mike Gagner (R2), Michael Link (LGL)

Purpose: Continue discussions regarding instream flow related resource issues that need to be addressed as part of 2013-2014 studies.

Dudley Reiser stated that the main purpose was to allow resource agencies an opportunity to provide more details on resource issues warranting investigation as part of 2013-2014 studies. He reminded the group that there are opportunities for some field efforts this year.

Dudley noted the email comments provided by Joe Klein and requested that he expand on the issues he presented. Some of ADFG issues include:

- Model flow vs. habitat relationships in all reaches affected by the project
- Complete a comprehensive analysis of fish habitat issues including: distribution, use, timing, and evaluation of project impacts
- Ice and potential effects on formation, breakup, etc. related to project operations
- Winter habitat use of fish
- Groundwater influences on fish distribution and how project operations may affect groundwater flows
- Water temperature and how regimes would change with project operations
- Time series analysis of habitats

Dudley acknowledged the need to focus on both mainstem and side channel habitats and that previous studies focused on side channel and slough habitats. He noted that the flow routing transects could also be used for evaluating mainstem habitat effects and that the radiotelemetry (fisheries study) studies would be used to help define main channel use.

Joe Klein indicated he would like to see more emphasis on mainstem habitats than was done in the 1980s.

Mike Buntjer requested a map displaying location of flow routing transects. Betsy McGregor noted that the location of the old ADF&G transects in lower river would need to be digitized and displayed along with flow routing transects in the middle river. This type of info will be useful in identifying data gaps and possibly high priority sampling locations.

Joetta Zablotney is going to generate a GIS map using modern coordinates and aerial photos. This map will be distributed to the group as part of 2013/2014 study plan and will need to be completed by March 20th. Betsy noted that Shawn O'Quinn – (DNR GIS) will assist with this effort.

Craig Addley said that most of the 1980s transects have been digitized and could be displayed on new maps. The group would like to have the transect locations QA/QCed on the ground.

Betsy McCracken asked whether the historic transects were based on habitat or fish use? This will need to be determined based on information review. She also would like to see a study to define unique habitat types, especially those associated with groundwater upwelling.

Dudley stated that groundwater is specifically covered under water quality, but that groundwater influences relative to spawning and rearing habitats and the effects of project operations on these habitats will need to be evaluated. One way for identifying areas of groundwater inflow is via Forward Looking Infrared (FLIR). This has been proposed for use in a test area to see if sufficient difference in temperature can be detected. If works on test area, then it would be expanded to other areas. Some limited assessment of groundwater was done in the 1980s. Dudley noted that this relates to the idea of different levels of study intensities based on resource use/sensitivity. This will be considered in developing the 2013-2014 study plans.

Craig Addley noted that extensive habitat mapping was done during 1980s studies – the majority of side channel, mainstem, and off channel habitats (sloughs) were evaluated under flows ranging from ~800-2,400 cfs. Studies identified spawning locations, juvenile fish and overwintering use of each habitat type and many of these habitat types were subsampled.

The group indicated that load following and ramping rates are a major concern. Stuart Beck described a procedure for evaluating these types of potential impacts using a varial zone analysis that would include an evaluation of stranding and trapping potential, along with redd dewatering.

The agencies requested a list of contractors that identify who is responsible for what studies/issues. Dudley indicated he will work with AEA on getting a list generated. Not all contractors are under contract yet.

Question raised: How will we study or detect channel change with flow regulation changes; i.e., change in hydrology will result in channel changes. Answer – this will be done as part of a number of studies including geomorphology, riparian analysis, ice study, and the instream flow habitat analysis. Part of these studies will evaluate bed profile and substrate compositions.

Question raised: will the flow routing model be used for channel change – Stuart Beck indicated it would be. Stuart also noted that there are ways to predict how project operations will affect changes in morphology and that this will be linked with SWIFS and riparian studies.

Question raised: can the model also be used to evaluate tributary confluences and how they will be affected? S. Beck stated the project would result in sediment supply interruptions – immediately below the dam the sediment supply will change with scour or incision, but some of this impact will be reduced by reductions in high flow events. The USGS is evaluating sediment changes.

Dudley noted that the overall goal is to try and link all of the channel and biological processes that may be affected by the project operations so that time series evaluations can be completed for each process (to the extent possible).

Question raised: will invertebrates be considered in the assessment of project effects? D. Reiser responded that changes in sediment and flow can affect invertebrates and they will be considered. May utilize varial zone analysis described by S. Beck to assess some of these impacts including area, timing, and duration of projected flow changes.

Question raised: will HSC curves be developed for invertebrates? D. Reiser noted that this has been done on other projects and will be considered as part of the SWIFS. However, it also possible that the issue of invertebrate habitats will be covered by fish habitat analysis, that may include use of guilds. Betsy McCracken is interested in potential changes that may result to invertebrate species richness and diversity.

The group noted that Project operations will alter the thermal regime related to flow releases, ADF&G would like to see HSC curves developed for multiple areas and over different time periods/flow levels. D. Reiser responded that we will conduct site-specific data collection but may need to use literature, professional opinion, enveloping and guiding to develop curve sets for some species.

Question raised: how many observations are necessary to build curves? D. Reiser noted this varies; some instances as few as 25-30 observations have been used, in others 75-100 or more have been used. Joe Klein stressed that he just wants to make sure that a good effort was going to be placed on collecting site-specific data.

Concerning the review of literature review and gap analysis/synthesis that will be undertaken this year, the agencies would like to be directed to pieces of information we identify that are especially useful to help them gain a good understanding the resources of the project area.

The group then shifted to a discussion of Riparian habitat. Bob Henszey asked about the types of studies that would be done to assess channel encroachment and the effects of project operations on cottonwood regeneration. He is concerned about potential effects of shallow groundwater table fluctuations and how that would influence cottonwood recruitment.

K. Fetherston indicated that models will be used to predict project operational effects on cottonwood/riparian veg. Joe Klein asked whether there is a published table that shows how seral stages and spp composition change over time. K. Fetherston noted that HEC-RAS and HEC-GeoRAS can be used to determine flow vs. riparian habitat relationships. This work will be coordinated with the ice assessment group and how conditions/ice sheer zones will affect cottonwood galleries. It will also be important to link riparian studies with groundwater, and fisheries at certain locations. Kevin noted that large fluctuations in flow can also increase bank erosion affecting riparian vegetation. The approach will be to intensively study small areas with the goal of being able to extrapolate results out to unsampled areas.

The teleconference adjourned at 5:00 ADT.

Notes from a meeting with ADFG Gene Conservation Lab, March 26, 2012

On phone: Betsy McGregor (AEA), Dani Evenson (R2)
In-person: ADFG: Bill Templin, Chris Habicht, Andy Barclay, Jack Erickson (briefly)
LGL: Michael Link, Bryan Nass, Jason Smith
HDR: James Brady

Looking for guidance and priorities for sampling in the middle Susitna. We can help collect the needed samples for Chinook. Tell us which samples are of greatest value to the Lab.

Sampling where? In tributaries only, or at fishwheel too? Only would do sampling at fishwheel in a future year if there was a mainstem spawning group identified.

Review Purpose and Objectives of tissue collections: baseline development, mark-recap utility, habitat use and juvenile redistribution questions, fish above Devils Canyon (are they distinct?), parental contributions above Devils, future possibility of testing water samples to indicate whether there are fish there or not. Test whether the fish above and those below Devils are genetically different.

ADFG concept: source-sink question, which deals with genetic variation. A new application for them so some aspects are uncertain, but known distribution means we probably don't need Fishwheel samples. Maybe need a netting program in tributaries to get adult samples. Protocol for sampling not defined yet and first samples will be first used for basic assessment of siblings, gauge number of adults above canyon, but want 200 from each trib. Recognizing likely limitation of number samples available. Andy to provide existing samples distribution for (preferred) live adults or very recent dead (heart tissue).

If ADFG is informed where spawning fish are, they can also go get themselves.

Samples could be processed this winter with results available next season.

Other species: opportunistic sampling of non-salmon (important sport fishery, important ecologically). Useful sample sizes 20-50 total each by area within watershed, up to 100 from around the watershed.

ADFG (Judy Berger) to provide kits. ADFG will provide information necessary to update our sampling permit (where to sample).

Axillary process as the part to sample for most fish.

Chinook, sockeye have some funding to process some samples, but not the others.

Anadromous vs. resident? size based sample collection?

AEA perspective (Betsy) - fish above Devils, are they different from those above.

To write a "study request" for 2013-14 (R2, Dani Evenson) to have a place in the cue for work to be done.

Michael Link

From: Erickson, Jack W (DFG) [jack.erickson@alaska.gov]
Sent: Thursday, March 29, 2012 5:00 PM
To: Michael Link
Subject: RE: Study plan, Susitna middle river habitat use (using telemetry and other)

Mike,

I am ~ ½ way through your plan. Can you call me Friday morning to discuss it?

From: Michael Link [mailto:MLink@lgl.com]
Sent: Wednesday, March 28, 2012 12:51 PM
To: Erickson, Jack W (DFG); Yanusz, Richard J (DFG); Willette, Mark (DFG)
Cc: Bryan Nass; Fair, Lowell F (DFG)
Subject: Study plan, Susitna middle river habitat use (using telemetry and other)

Jack, Richard, and Mark,

Here is the "final draft" study plan that we pulled together for AEA based on the earlier plan prepared by others. This document was just posted on the AEA website and, along with several other study plans, will be the topic of discussion at next Thursday's AEA fish meeting (~10am-2pm).

I look forward to hearing your feedback. The proposed effort of using side-scan/DIDSON to locate spawning fish in turbid water is an Aquacoustics (Don Degan) led initiative. We have suggested using our DIDSON for helping to position the fishwheels and make some tests of fish presence/behavior offshore and around the fishwheels. The main issue with the latter is primarily related to testing whether all Chinook are equally vulnerable to capture. Of course, we can address some of that with carcasses in Portage but I'd sooner know in-season. The mainstem stations are to characterize the comings (and goings) of the mainstem side channel/slough chum and sockeye as it changes with time of year, discharge, etc. The two sloughs will likely represent the bulk of these tagged species. Portage and Indian will probably see 90% of the tagged kings.

One thing you will no doubt take note of is the lower river aerial survey effort; agencies have urged AEA to better characterize mainstem use in the lower river (Flathorn to three rivers) and would like us to track the fish you tag in the lower river to a higher temporal and spatial resolution than currently planned. As we discussed briefly via email, this will be a challenge but we've propose an approach to accomplish what has been asked of us. If this, or something similar, were to work maybe we could save you some focused fixed-wing effort in the mainstem. I'm not suggesting you turn off when transiting, but we might create some extra time for you to focus efforts elsewhere. Just a thought; I know you guys have plenty to do across all the studies in the area.

Regarding the integration/collaboration of the telemetry data analysis, we allude to this in the study plan but as you know, we do not have a formal approach for this yet, other than an informal "agreement in principal"/goodwill/etc. Just let me know if there is anything I should be doing to catalyze the data sharing agreement or if you would like to pull back some on this aspect.

Despite it coming together in relatively short order, it has gone through a few iterations, so there is more behind many of these things than may meet the eye. Let me know if you would like to talk about any of this prior to Thursday's meeting. I suspect Thursday may only provide for fairly limited discussion.

Michael

SUSITNA-WATANA
HYDROELECTRIC PROJECT

RECORD OF TELEPHONE CONVERSATION

AEA Team Member		Other Party	
Name:	*Michael Link*	**Name:**	*Jack Erickson*
Organization:	*LGL Alaska Research Associates*	**Organization:**	*ADFG*
Study Area:	*Fisheries Resources*	**Phone Number:**	*Telephone call*
Date:	*March 30, 2012*	**Time:**	*10:00*

Call Placed by: [x] AEA Team [ ] Other Party

Subject: Study design for the salmon escapement study

Topics:

This call was to review the written comments provided by ADFG on the 2012 study plan for habitat utilization and salmon escapement study. ADFG provided useful comments on the efficacy and utility of the proposed methods to catch, tag, and track salmon in the Susitna. We reviewed study design protocols, and how to coordinate and collaborate with ADFG in the 2012 field studies.

The 2013-14 study plan was largely built upon the 2012 study plan, with additional components added based on ADFG's study request for additional work in the lower river on Chinook and coho salmon.

[*note; please save files with agency name and date of event using YYYYMMDD]*

SUSITNA-WATANA
HYDROELECTRIC PROJECT

RECORD OF IN-PERSON MEETING

AEA Team Member		Other Party	
Name:	*Michael Link*	**Name:**	*Jack Erickson*
Organization:	*LGL Alaska Research Associates, Inc.*	**Organization:**	*ADFG*
Study Area:	*Fisheries Resources*	**Phone Number:**	*267-2398*
Date:	*March 2, 2012*	**Time:**	
Call Placed by: ☐ AEA Team ☐ Other Party			

Subject: 2013-14 Study Plan, Salmon Escapement and Fish Genetics

Meeting notes, March 2, 2012, In-person meeting with Jack Erickson, ADFG, and Michael Link, LGL

Purpose of meeting: to discuss the design and research techniques to characterize spawning destination and abundance of Chinook and other salmon species in the Susitna River.

Compared and contrasted the utility of genetic and traditional mark-recapture (spaghetti and radio tagging) methods for estimating abundance and stock composition (i.e., apportionment) among the different stocks of salmon.

Agreed that it would be good to evaluate the effectiveness of fishing in the lower river and distribution among streams in 2012 before deciding on whether to emphasize genetics over traditional mark-recapture approaches.

[*note; please save files with agency name and date of event using YYYYMMDD*]

Betsy McGregor

From:	Klein, Joseph P (DFG) <joe.klein@alaska.gov>
Sent:	Tuesday, April 17, 2012 11:12 AM
To:	Betsy McGregor
Cc:	Clark, Robert A (DFG); Vincent-Lang, Douglas S (DFG); eric Rothwell; betsy_mccracken@fws.gov; michael_buntjer@fws.gov; tsundlov@blm.gov; msonderg@blm.gov; susan walker; bob_henszey@fws.gov; LaCroix.Matthew@epamail.epa.gov; cassie_thomas@nps.gov; eric Rothwell; Baker, Tim (DFG); Benkert, Ronald C (DFG); Burch, Mark E (DFG); Erickson, Jack W (DFG); Fair, Lowell F (DFG); Fink, Mark J (DFG); Holen, Davin L (DFG); Lingnau, Tracy L (DFG); Miller, Monte D (DFG)
Subject:	ADF&G Comments on April 2-6 Susitna-Watana Project Meetings

Betsy-

ADF&G appreciated the meetings April 2 - 6 to discuss fish and wildlife related issues associated with the 2012 and 2013-14 study plans for the Susitna-Watana Hydroelectric project.

We offer the following comments on information presented.

Aquatic Resources Study within the Access Alignment, Transmission Alignment, and Construction Area

- If the first fish survey does not detect any fish, we recommend a second visit be conducted.
- The Habitat Division recommends conducting site visits along the transportation corridor(s) as early as possible to enable discussion of proposed stream crossings, locations, and designs and discussion of permitting requirements associated with those crossings.

Susitna-Watana Instream Flow Study

- Include fish behavioral response based assessments with the study. For example, fry/juvenile distances to cover/edge of water.
- We would like to read information on previous instream flow assessments performed at the Baker and Boundary Hydroelectric Relicensing projects that were referenced during the meetings.

Geomorphology

- A description is needed on how channel maintenance flows will be determined to estimate the magnitude, duration, timing and rate of change.

Fish

- Rotary traps used to assess fish outmigration should operate for the entire period of outmigration.

- Use of underwater video cameras, radio telemetry, and/or remote operated vehicles should be considered for assessing presence/absence of overwintering habitats in the Susitna River and if successful, developing habitat suitability curves.

Temperature Monitoring

- After review of the latest draft 2012 study plan, the Habitat Division has determined that Fish Habitat Permits should be obtained for the temperature monitoring stations. Enough information on monitoring locations and description of temperature monitoring station design is available in the study plan to proceed with developing permits. AEA or its contractor should contact the Palmer Habitat office to discuss these stations and submit permit applications.

Habitat Mapping/Surveys/Typing

- Training on the selected protocol across disciplines needs to be integrated into the study plans to further maintain data consistency and reduce observer bias during surveys.

Regards,

Joe Klein, P.E.
Supervisor Aquatic Resources Unit
Alaska Department of Fish and Game
333 Raspberry Rd
Anchorage, AK 99518
(907) 267-2148
joe.klein@alaska.gov

Betsy McGregor

From:	Michael_Buntjer@fws.gov
Sent:	Monday, April 23, 2012 1:58 PM
To:	Betsy McGregor; MaryLou Keefe
Cc:	Ann_Rappoport@fws.gov; Lori_Verbrugge@fws.gov; Betsy_McCracken@fws.gov; Bob_Henszey@fws.gov; Jennifer_Spegon@fws.gov; joe.klein@alaska.gov; jack.erickson@alaska.gov; LaCroix.Matthew@epamail.epa.gov; Craig Addley; Steve Padula
Subject:	USFWS concerns about proposed Susitna-Watana load-following operations on fish populations

Betsy:

The U.S. Fish and Wildlife (Service) appreciates the Alaska Energy Authority's continued willingness to work collaboratively with resource agencies to identify and address concerns expressed by resource agencies about the Susitna-Watana Hydroelectric Project. This email is in response to your verbal request for comments and recommendations related to fish and wildlife resources associated with the 2012 and 2013-2014 study plans. Here we focus primarily on the proposed load-following operations, uncertainty about ramping rates or regimes, and need for winter distribution, abundance, and habitat use information for juvenile anadromous fish and resident fish.

The Service and other resource agencies have expressed concerns at previous work group meetings about the proposed load-following operations, particularly in winter (October through April). The timeframe between spawning and outmigration of juveniles is critical for anadromous species populations in terms of proposed project operations. However, much of the focus at work group meetings for fish, to date, has been on habitat modeling and developing habitat suitabilty curves.

Load-following operations and ramping regimes, particularly those proposed in winter (October through April), can disrupt fish spawning, spawning success, egg incubation, incubation success, fry emergence times, and emergence success. Post emergence, smaller juvenile fish (less than about 50 mm long) are most vulnerable to potential stranding because of a weaker swimming ability and typical preference of habitat types near shore. Therefore, it is important to know when and where fish are spawning, when fry emergence occurs (both date and time of day), and the distribution and abundance of wintering juvenile fish.

Load-following operations (specifically flow fluctuations) from hydropower operations can create a varial zone between high and low water operations where the biomass of algae and macroinvertebrates is significantly reduced. Because macroinvertebrates are a primary food source for many riverine fish (and particularly for juvenile fish in the Susitna River), extreme flow fluctuations can adversely affect fish growth if food is limiting. Changes in water temperature, emergence times, and daily flow fluctuations could also affect fish growth, fish condition (responding to constant changes in flow), outmigration (for anadromous species), and overall survival of both resident and anadromous fish species.

The rate and magnitude of flow change need to be evaluated seasonally on the displacement and potential stranding of spawning adults, dewaterating of redds, and stranding of juveniles. Because of the extreme environment, freezing of incubating eggs or freezing of fish stranded in shallow habitats could also occur with project operations. Stranded fish would also be more vulnerable to predation from eagles and bears.

The 1980s studies focused on occupied fish habitats (particularly for juveniles) and did not evaluate areas where (nor the reasons why) fish were not present. This will make extrapolating results to the overall river difficult. Therefore, it is critical this information be collected in 2012-2014.

Much of the proposed work for fish and wildlife resources appears to rely on comparing results to the 1980s, and where results are similar, concluding there is substantial baseline information to evaluate potential effects of the proposed project. However, there are substantial data gaps in biological information both seasonally and by reach. For instance, there is almost no winter distribution and abundance information for resident or juvenile anadromous fish in the Susitna River (limited observations in October and November from 1980s studies) and limited biological information in both the upper and lower reaches (as defined in the PAD) to compare with 2012-2014 study results. This also reiterates our previous concerns at both meetings and in writing that adequate information cannot be collected in 2-3 years of study.

Potential methods

ADF&G suggested considering use of underwater video for assessing presence/absence of fish in wintering habitats (per 4/17/12 Joe Klein email). In addition, we suggest that snorkelling or scuba diving techniques also be considered to assess presence/absence of fish in wintering habitats, as well as determining winter distribution and abundance. Snorkelling or diving could also be used with egg baskets to monitor egg development, egg survival, and emergence times under baseline conditions.

Mike

Mike Buntjer
US Fish and Wildlife Service, Anchorage Field Office
Conservation Planning Assistance
605 W. 4th Ave, Room G-72
Anchorage, AK 99501
(907)271-3053
(907)271-2786 FAX

SUSITNA-WATANA
HYDROELECTRIC PROJECT

RECORD OF TELEPHONE CONVERSATION

AEA Team Member		Other Party	
Name:	*MaryLouise Keefe*	**Name:**	*Susan Walker, see other listed below*
Organization:	*R2 Resource Consultants, Inc.*	**Organization:**	*NMFS, USFWS, ADFG, AEA*
Study Area:	*Fisheries Resources*	**Phone Number:**	*Conference call*
Date:	*April 26, 2012*	**Time:**	
Call Placed by: [X] AEA Team [ ] Other Party			

Others on Call: E. Rothwell, M. Buntjer, B. McCracken, J. Ericksen, J. Klein, M. Sondergaard, M. Cutlip, B. McGregor.

Subject: 2013-14 Study Requests

Discussion:
This conference call was set up to have open discussion of objectives and approaches that are appropriate for implementation during 2013-14 studies.

The conversation started with a discussion of the ILP process and time frame. Matt Cutlip addressed agency questions and discussed how and when it is appropriate for the agencies to have input into studies…stating basically start now and continue through the process.

The conversation turned to study requests. The group moved through the current ideas and discussed how objectives could be refined. We discussed the approaches for meeting study objectives…such as using radio-telemetry and pit tags to monitor seasonal movements of fish, use of smolt traps, the ability to snorkel or dive all seasons, and the need to collect habitat suitability data in both turbid and clear water. We talked about the need to tie barriers together with habitat and seasonal evaluations of barriers. ADFG requested habitat crew training prior to data collection.

Discussion began about potential target species to consider: eulachon, rainbow trout, Dolly Varden, whitefish, Pacific lamprey, burbot, and northern pike. The potential concern was raised that pike may find refuge in winter with increased flows in the mainstem.

A brief discussion of the macroinvertebrate study plan ensued. We discussed seasonal sampling, nesting sites within the river specific habitat classification scheme being developed, and adding a randomness element. We discussed adding a qualitative assessment of fish feeding on macros.

SUSITNA-WATANA
HYDROELECTRIC PROJECT

RECORD OF TELEPHONE CONVERSATION

AEA Team Member		Other Party	
Name:	*Michael Link*	**Name:**	*See below.*
Organization:	*LGL Alaska Research Associates, Inc.*	**Organization:**	*ADFG*
Study Area:	*Fisheries Resources*	**Phone Number:**	*Telephone call / In person meeting*
Date:	*April 26, 2012*	**Time:**	*13:00-1430*

Call Placed by: [x] AEA Team [ ] Other Party

Notes from a meeting with ADFG Gene Conservation Lab, April 26, 2012
On phone: Betsy McGregor (AEA), Dani Evenson (R2)
In-person: ADFG: Bill Templin, Chris Habicht, Andy Barclay, Jack Erickson (briefly)
LGL: Michael Link, Bryan Nass, Jason Smith
HDR: James Brady

Looking for guidance and priorities for sampling in the middle Susitna. We can help collect the needed samples for Chinook. Tell us which samples are of greatest value to the Lab.

Sampling where? In tributaries only, or at fishwheel too? Only would do sampling at fishwheel in a future year if there was a mainstem spawning group identified.

Review Purpose and Objectives of tissue collections: baseline development, mark-recap utility, habitat use and juvenile redistribution questions, fish above Devils Canyon (are they distinct?), parental contributions above Devils, future possibility of testing water samples to indicate whether there are fish there or not. Test whether the fish above and those below Devils are genetically different.

ADFG concept: source-sink question, which deals with genetic variation. A new application for them so some aspects are uncertain, but known distribution means we probably don't need Fishwheel samples. Maybe need a netting program in tributaries to get adult samples. Protocol for sampling not defined yet and first samples will be first used for basic assessment of siblings, gauge number of adults above canyon, but want 200 from each trib. Recognizing likely limitation of number samples available. Andy to provide existing samples distribution for (preferred) live adults or very recent dead (heart tissue).

If ADFG is informed where spawning fish are, they can also go get themselves.

Samples could be processed this winter with results available next season.

Other species: opportunistic sampling of non-salmon (important sport fishery, important ecologically). Useful sample sizes 20-50 total each by area within watershed, up to 100 from around the watershed.

ADFG (Judy Berger) to provide kits. ADFG will provide information necessary to update our sampling permit (where to sample).

Axillary process as the part to sample for most fish.

Chinook, sockeye have some funding to process some samples, but not the others.

Anadromous vs. resident? size based sample collection?

AEA perspective (Betsy) - fish above Devils, are they different from those above.

To write a "study request" for 2013-14 (R2, Dani Evenson) to have a place in the cue for work to be done.

river productivity study request

MaryLou Keefe [mkeefe@r2usa.com]

Sent: Friday, May 04, 2012 11:59 AM

To: Michael_Buntjer@fws.gov

Cc: Betsy McGregor

Attachments: draft 2013-14SR River Pro~1.docx (769 KB)

---

hi mike...you had indicated an interest in this one last week so here you go. fyi it is a draft of one of our more comprehensive requests...format will change from this to the formal one, but it may help you with what you are working on.

have a good, restful weekend!

MaryLou

SUSITNA-WATANA
HYDROELECTRIC PROJECT

RECORD OF MEETING

AEA Team Member		Other Party	
Name:	*James Brady*	**Name:**	*Joe Buckwalter*
Organization:	*HDR*	**Organization:**	*ADF&G, Division of Sport Fisheries, Habitat Biologist*
Study Area:	*Upper Susitna River Fisheries*	**Phone Number:**	
Date:	*5/17/2012*	**Time:**	

Meeting requested by: [X] AEA Team [ ] Other Party

Meeting Location: HDR Office, Anchorage, AK

Attendees at Meeting:
James Brady (HDR), Erin Cunningham (HDR), Joe Buckwalter (ADF&G)

Subject:
Upper Susitna River Fisheries Distribution and Abundance Study Area - Survey Area for Potential Chinook Salmon Presence

Discussion:
Joe provided valuable logistical advice for sampling fish resources within the tributaries of the Upper Susitna River including the Oshetna River, Kosina Creek, Fog Creek and others. We discussed boat electrofishing methods that he had found to improve capture success in these drainages. We also discussed the Odyssey Fisheries Database System that ADF&G has been developing over the past ten years. Joe provided us with a generalized schema and screen shots of the tablet based mobile GIS field data capturing application incorporated in the Odyssey system.

SUSITNA-WATANA HYDROELECTRIC PROJECT

RECORD OF TELEPHONE CONVERSATION

AEA Team Member		Other Party	
Name:	*MaryLouise Keefe*	**Name:**	*Susan Walker, see other listed below*
Organization:	*R2 Resource Consultants, Inc.*	**Organization:**	*NMFS, USFWS, ADFG*
Study Area:	*Fisheries Resources*	**Phone Number:**	*Conference call*
Date:	*May 18, 2012*	**Time:**	

Call Placed by: [X] AEA Team [ ] Other Party

Others on Call: M. Buntjer, R. Benkert, D. Reiser, B.McGregor, J. Simon, R. Campbell

Subject: 2013-14 Winter Sampling Discussion
Meeting Notes are bulleted below.

- Objectives of study: to document winter habitat use by fish distribution & abundance, & to assess movement; bigger picture objective as it relates to ISF fish-habitat relationships & understanding potential project impacts
- Approach: need to be open to all alternatives at this time
- 1980s data in the reports, but synthesis of data may not be available until late summer
- need to move forward with FERC study plans, despite the lack of data synthesis at this point in time
- if substantial changes in flow from one year to the next, 25% of habitats sampled in first year could be resampled in 2nd year, with remaining survey area being new habitats not surveyed in the 1st year
- 1980s data has strong indications that fish are moving among macro-habitats; might be good to know when, why, etc.... especially for understanding potential operational impacts
- there are other limitations to consider & it would be interesting to know how they were addressed in the 1980s (e.g., lack of daylight; slushing over of ice openings; time of day that sampling was conducted; daily fish behavior patterns)
- effectiveness of different methods – minnow traps might be ok for presence data
- understanding role of temperature in movements & habitat use – open areas & sloughs
- may want to use multiple methods at some sites, & only select methods at others
- may want to look broadly for fish & then identify sites for more intensive sampling
- upper reach is less likely to need this level of sampling effort
- cost considerations – e.g. $50K for equipment for single PIT tag array
- Betsy wants to start sampling winter 2012-2013, for a total of 3 sampling seasons by break-up 2015
- questions about effectiveness of electrofishing
- seining & minnow trapping appeared to be most effective
- PAD mentions stable winter flows...reduced stranding – Betsy will check that for accuracy
- emergence times for chum salmon – Feb-Mar per PAD, but Mike couldn't confirm this
- what techniques were used to determine time of emergence?
- other early life history topics – Mike isn't sure how much he trusts the 1980s reports
- spawning habitat can be coupled with ISF studies; with temperature data incorporated information about incubation can be obtained; SNTEMP model is capable of calculating temps & emergence times;

ultimately can allow for assessment of potential effects on incubation & emergence; also temp changes in sloughs can be related to mainstem flows, topping over in sloughs; also consider information from inlet/outlet connectivity & temp responses in sloughs, etc.; redds above elevation x subject to dewatering, whereas other redds subject to freezing (intragravel temp loggers could be used)

- may be valuable to break-down the fish winter sampling objective into more specific objectives that target habitat use, presence/distribution, abundance, & movement, etc. separately

MLK's Fish Winter Sampling Discussion Points

1. Is it sufficient to focus sampling below RM 180, given potential for project to influence winter flows, temperature, and ice formation?

Mike: generally no; but may be species dependent; would be good to know what percent of population is u/s of the proposed dam location.

2. There are 180 miles of mainstem habitat and many more when we consider side channels and sloughs. How best stratify for winter sampling?

Mike: stratified random approach based on geomorphic reach & habitat type

-Should we sample in same locations at 1980s? Only? At least?

Mike: hesitant until we know more about the 1980s methods & data; at least going back to some sites might be a good idea (e.g., Slough 11)
Sue: thinks it should be "at least"

-Should we stratify by geomorphic reach? yes

-Should we stratify by habitat type and if so what level? yes

3. Should we spread sampling methods out to cover more habitat or co-locate where appropriate, i.e. intensive areas concept.

see bullets above

4. How much coverage is enough? Is there a certain percentage based on feature numbers or distance that we should strive for?

question was not answered

SUSITNA-WATANA HYDROELECTRIC PROJECT

RECORD OF TELEPHONE CONVERSATION

AEA Team Member		Other Party	
Name:	*James Brady*	**Name:**	*Andy Barclay*
Organization:	*HDR*	**Organization:**	*ADF&G, Genetics Lab*
Study Area:	*Upper Susitna River*	**Phone Number:**	
Date:	*5/18/12*	**Time:**	
Call Placed by: [X] AEA Team [ ] Other Party			

Others on Call: HDR Study Team

Subject:
Genetic sample collection during the Upper Susitna River Fish Distribution and Abundance Study 2012 field effort

Discussion:
The purpose of the teleconference was to coordinate methods and supplies for collecting genetic tissue samples of fish species in conjunction with 2012 field activities. ADF&G will provide protocol materials by e-mail and HDR will pick up sampling kits from ADF&G around the first of July.

SUSITNA-WATANA
HYDROELECTRIC PROJECT

RECORD OF TELEPHONE CONVERSATION

AEA Team Member		Other Party	
Name:	*MaryLouise Keefe*	**Name:**	*Susan Walker, see other listed below*
Organization:	*R2 Resource Consultants, Inc.*	**Organization:**	*NMFS, USFWS, ADFG*
Study Area:	*Fisheries Resources*	**Phone Number:**	*Conference call*
Date:	*June 20, 2012*	**Time:**	
Call Placed by:	X AEA Team	☐ Other Party	

Others on Call: M. Buntjer, B. McCracken, R. Benkert, J. Erickson

Subject: 2013-14 Study Requests

Discussion:

This conference call was set up to follow up on some uncertainty around semantics used in objectives that were discussed during the June 12th Fish and Aquatic TWG meeting. Discussion focused on clarifying the semantic issues regarding use of "counts" versus "escapement" and "all species" versus "all species captured".

The group also engaged in an open discussion of where and how to modify the macroinvertebrate sampling design with respect to sampling in channel margins and large wood as substrate. The conclusion was that a protocol that removed a piece of the wood and expanded the data was reasonable. In addition, it was decided that channel margins baseline sampling for macroinvertebrates should be conducted in a manner that allows for comparison post-project. This may not entail sampling in the exact same location but in at a similar depth and velocity in the same general area.

Michael Link

From: Erickson, Jack W (DFG) [jack.erickson@alaska.gov]
Sent: Thursday, June 21, 2012 4:25 PM
To: Michael Link
Cc: Klein, Joseph P (DFG); Erickson, Jack W (DFG); Templin, Bill D (DFG)
Subject: Word version of DRAFT study request prepared by F&G
Attachments: DRAFT study request for genetics sampling.docx

Michael

Per your request, attached is a WORD version of Study Request ADF&G submitted to FERC earlier this month. PLEASE note, this may not match up with text submitted by ADF&G in its comments to FERC. I hope it assists you with your efforts to prepare the genetics study plan.

Jack Erickson
Regional Research Coordinator
Division of Sport Fish
ADF&G
907-267-2398

SUSITNA-WATANA
HYDROELECTRIC PROJECT

RECORD OF IN-PERSON MEETING

AEA Team Member		Other Party	
Name:	*Michael Link*	**Name:**	*Jack Erickson*
Organization:	*LGL Alaska Research Associates, Inc.*	**Organization:**	*ADFG*
Study Area:	*Fisheries Resources*	**Phone Number:**	*267-2398*
Date:	*June 28, 2012*	**Time:**	
Call Placed by: ☐ AEA Team ☐ Other Party			

Subject: 2013-14 Study Plan, Salmon Escapement and Fish Genetics

Purpose of meeting: review the technical approaches of the proposed study plans for proposed salmon escapement and fish genetics studies.

Discussed the results from efforts to capture and tag Chinook salmon at RM 30 and RM 120 (Curry) over the last 5 weeks.

Given the results from 2012 fishing efforts in May and June, the overall approach to the study design for the escapement study was valid and traditional mark-recapture was likely technically feasible.

Agreed that it was good to propose a continuation of the concept of assessing the feasibility of using genetics as a tool to estimate system-wide abundance.

Of course, this will depend on continued development of the Susitna Chinook baseline. There was general agreement that the PSP was built on a feasible study design.

[note; please save files with agency name and date of event using YYYYMMDD]

SUSITNA-WATANA
HYDROELECTRIC PROJECT

RECORD OF TELEPHONE CONVERSATION

AEA Team Member		Other Party	
Name:	*Scott Prevatte*	**Name:**	*Sam Ivey*
Organization:	*HDR*	**Organization:**	*ADF&G*
Study Area:	*Upper Susitna River*	**Phone Number:**	
Date:	*07/10/12*	**Time:**	

Call Placed by: [X] AEA Team [ ] Other Party

Others on Call:

Subject: Coordination of Chinook Salmon Aerial Spawning Surveys

Discussion:

Scott called Sam on July 10. Scott informed Sam of AEA's intention to replicate the departments adult salmon aerial count in Indian Creek as a means of validation of results due to the anticipated limits of testing observer efficiency in the Upper River.

Sam said ADFG was beginning Susitna aerial surveys on Monday July 16 and planned to complete Indian Creek and other tributaries up river tribs during the last week of July. Scott informed Sam that HDR also plans to begin surveys in the Upper River during the last week of July. Sam noted July 26 as a tentative date for their Indian Creek survey and mentioned that the date may be flexible by a day or two because ADFG has many other tributary systems in the area to survey.

Sam requested that Scott check in with ADFG as the date gets closer for final coordination in picking the best day for both ADFG and HDR to survey Indian Creek.

From: Erickson, Jack W (DFG) [mailto:jack.erickson@alaska.gov]
Sent: Tuesday, July 10, 2012 9:33 AM
To: Michael Link; Betsy McGregor
Cc: Bryan Nass; Erickson, Jack W (DFG); Klein, Joseph P (DFG)
Subject: RE: Tuesday, project meeting, LGL/Fishwheels/Radiotagging/etc.

Gang,

I just confirmed with Palmer staff that we will be in the **air today** for the second tracking flights.

On a side note, the staff in Palmer are scheduled to start their Chinook escapement count flights next week (weather permitting). These are our annual helicopter flights on ~ 24 streams.

AEA has provided ADF&G additional funding to fly six of the streams (Willow, Little Willow, North Fork Kashwitna, Montana, Clear Creek, and Prairie Creek) three times so we can evaluate the variation/precision of the helicopter surveys.

Jack

From: Ivey, Samuel S (DFG) [mailto:samuel.ivey@alaska.gov]
Sent: Friday, July 13, 2012 8:57 AM
To: Cunningham, Erin E.; Piorkowski, Robert J (DFG)
Cc: Brady, James
Subject: RE: PERMIT: Fish Resource Permit SF2012-151 (Brady/HDR-Susitna River above Devil's Canyon-local Fish)

I am OK with the requested additional samples and only request otolith for the lake trout if possible.

Thanks.

From: Cunningham, Erin E. [mailto:Erin.Cunningham@hdrinc.com]
Sent: Thursday, July 12, 2012 11:20 AM
To: Piorkowski, Robert J (DFG)
Cc: Brady, James; Ivey, Samuel S (DFG)
Subject: RE: PERMIT: Fish Resource Permit SF2012-151 (Brady/HDR-Susitna River above Devil's Canyon-local Fish)

Okay, great, will print this out and attach...

As far as the other issue goes, it was an add-on to this project (requested by AEA). James is actually looking into these details now, so we'll get back to you with additional information, either way.

Thanks again.

ERIN CUNNINGHAM | **HDR Alaska, Inc.**
Fisheries Biologist

2525 C Street, Suite 305 | Anchorage, AK 99503
907.644.2115
erin.cunningham@hdrinc.com | hdrinc.com

From: Piorkowski, Robert J (DFG) [mailto:robert.piorkowski@alaska.gov]
Sent: Thursday, July 12, 2012 11:10 AM
To: Cunningham, Erin E.
Cc: Brady, James; Ivey, Samuel S (DFG)
Subject: RE: PERMIT: Fish Resource Permit SF2012-151 (Brady/HDR-Susitna River above Devil's Canyon-local Fish)
Importance: High

Yo Erin,

There are now 20+ amendment requests and a similar number of FRP applications in front of yours so it will take awhile before I am formally able to write you an amendment.

As to the added sampling locations, please consider this email approval for sampling the additional sites. Print off this email and attach it to the permit.

As to the additional fish to be sampled, am I correct in assuming this is an add-on request from the contracting agency? Please confirm if so. If this is part of another project, it would be best to add you onto their permit via an amendment.

If the former, please send a page long write-up of the issue, background and methodology to be followed along with the lab that will be doing the work.

SAM—are you okay with the additional harvest of burbot and Lake trout? When lake trout are harvested in other areas the AMBs generally put strict sideboards on methodology used and the size taken along with a request for otoliths.

Thanks and cheers,

Bob Piorkowski, Ph. D.
Fish Resource Permit Program Coordinator
Alaska Department of Fish and Game-SF
Box 115526, 1255 W. 8th Street
Juneau, AK 99811-5526
(907) 465-6109 phone (907) 465-2772 fax
robert.piorkowski@alaska.gov

From: Cunningham, Erin E. [mailto:Erin.Cunningham@hdrinc.com]
Sent: Thursday, July 12, 2012 10:48 AM
To: Piorkowski, Robert J (DFG)
Cc: Brady, James
Subject: RE: PERMIT: Fish Resource Permit SF2012-151 (Brady/HDR-Susitna River above Devil's Canyon-local Fish)

Hi Bob,
Thanks again for your help.
I think we only need your response on two more items:

1. **Location**: Our study area will also include creeks within Devils Canyon, so the location should specify within as well as above Devils Canyon.
2. **Final Disposition**: Under the section specifying the number of fish that may be killed and sampled, we would like to add up to 10 Lake Trout and Burbot each. This is for tissue sampling used for metals analysis of species used for human consumption and species preyed upon by raptors and furbearers.

Thanks!
Erin C.

ERIN CUNNINGHAM | **HDR Alaska, Inc.**
Fisheries Biologist

2525 C Street, Suite 305 | Anchorage, AK 99503
907.644.2115
erin.cunningham@hdrinc.com | hdrinc.com

From: Brady, James
Sent: Monday, May 21, 2012 10:36 AM
To: 'Piorkowski, Robert J (DFG)'; Cunningham, Erin E.
Cc: Ivey, Samuel S (DFG); Lewis, Bert A (DFG); Bethe, Michael L (DFG); Daigneault, Michael J (DFG); DFG, FMPD Permit Coordinator (DFG sponsored); Boyle, Larry R (DFG); 'Betsy McGregor'
Subject: RE: PERMIT: Fish Resource Permit SF2012-151 (Brady/HDR-Susitna River above Devil's Canyon-local Fish)

Greetings Bob,
I have reviewed the FRP referenced above and have two additional requests/clarifications at this time.

3. **Location**: Our study area will include creeks within Devils Canyon, so the location should specify within as well as above Devils Canyon.
4. **Final Disposition**: Under the section specifying the number of fish that may be killed and sampled, we would like to add up to 10 Lake Trout and Burbot each. This is for tissue sampling used for metals analysis of species used for human consumption and species preyed upon by raptors and furbearers.

I also have a question about the reference to Appendix 1 under Department Sample Requirements... "(See Stipulation #13 and Appendix 1 for sampling details)". There was nothing labeled Appendix 1 on the permit. Is this a reference to the permit stipulations or something else.

Thanks!
James

James Brady
HDR Alaska
907-644-2011

From: Piorkowski, Robert J (DFG) [mailto:robert.piorkowski@alaska.gov]
Sent: Monday, May 14, 2012 2:01 PM
To: Brady, James; Cunningham, Erin E.
Cc: Ivey, Samuel S (DFG); Lewis, Bert A (DFG); Bethe, Michael L (DFG); Daigneault, Michael J (DFG); DFG, FMPD Permit Coordinator (DFG sponsored); Boyle, Larry R (DFG)
Subject: PERMIT: Fish Resource Permit SF2012-151 (Brady/HDR-Susitna River above Devil's Canyon-local Fish)

Dear James:

Please find attached your ADF&G Fish Resource Permit (SF2012-151). You need to read this permit carefully not only to understand what you are authorized and required to do but also to check for mistakes that must be corrected immediately by contacting us. If your plans are modified later on (e.g. personnel changes, larger than expected collections, different sampling locations, etc), contact us as soon as you know so that an amendment to your permit can be prepared and issued in time to avert disruptions to planned field work. Failure to abide by permit requirements or to amend your permit when conditions change are permit violations that can result in a citation and/or loss of your permit.

Please be sure that you and all authorized personnel carry a copy of the permit while conducting collecting activities.

A report detailing all collections for this permit is due on or before January 31, 2013. Please use the ADF&G data submissions form for this task. If you do not have the opportunity to utilize your permit, please submit a letter or email stating that the permit was not used. A telephone message is not sufficient.

Please use the subject line in all future correspondence regarding this permit--thanks

Wishing you success with your project,

Bob Piorkowski

Bob Piorkowski-Ph.D.
Fish Resource Permit Program
(907) 465-6109
Robert.Piorkowski@alaska.gov

From: Cunningham, Erin E. [mailto:Erin.Cunningham@hdrinc.com]
Sent: Friday, July 13, 2012 3:06 PM
To: Betsy McGregor; Watana
Subject: Consultation Record: Agency coordination, HDR & ADF&G. FW: PERMIT: Fish Resource Permit SF2012-151 (Brady/HDR-Susitna River above Devil's Canyon-local Fish)

ERIN CUNNINGHAM | **HDR Alaska, Inc.**
Fisheries Biologist

2525 C Street, Suite 305 | Anchorage, AK 99503
907.644.2115
erin.cunningham@hdrinc.com | hdrinc.com

From: Cunningham, Erin E.
Sent: Thursday, July 12, 2012 9:27 PM
To: Habicht, Chris (DFG); Brady, James
Cc: Berger, Judy M (DFG); Barclay, Andy W (DFG)
Subject: RE: PERMIT: Fish Resource Permit SF2012-151 (Brady/HDR-Susitna River above Devil's Canyon-local Fish)

thanks Chris - i really enjoyed talking to both you and judy earlier today - it was very helpful...

James Brady (here at HDR) is leading the adult salmon surveys. i spoke with him earlier and he is totally on board with keeping you guys in the loop in regards to our adult salmon surveys (and genetic sampling efforts) - sounds like he has already coordinated with Andy a bit but will be sure to include you all on his emails. i've included him on this email as well, just so we're all in the know. :)

so, stay tuned... and enjoy your summer as well!

(hopefully we get a little more sunshine before too long).

From: Habicht, Chris (DFG) [chris.habicht@alaska.gov]
Sent: Thursday, July 12, 2012 1:44 PM
To: Cunningham, Erin E.
Cc: Berger, Judy M (DFG); Barclay, Andy W (DFG)
Subject: RE: PERMIT: Fish Resource Permit SF2012-151 (Brady/HDR-Susitna River above Devil's Canyon-local Fish)

Hi Erin,

Nice talking with you earlier today. I wish you luck collecting all the genetics samples above Devil's Canyon this year.

I've Cc'ed Judy and Andy on this email. Judy is our archivist and she can help you with sampling supplies. Andy runs all genetics projects within Cook Inlet and is specifically working on the Chinook salmon baseline. Please keep us all in the loop, especially with information for collecting Chinook salmon.

Thanks and have a great summer.

Chris.

From: Berger, Judy M (DFG)
Sent: Thursday, July 12, 2012 12:35 PM
To: Habicht, Chris (DFG)
Subject: FW: PERMIT: Fish Resource Permit SF2012-151 (Brady/HDR-Susitna River above Devil's Canyon-local Fish)

From: Cunningham, Erin E. [mailto:Erin.Cunningham@hdrinc.com]
Sent: Thursday, July 12, 2012 10:56 AM
To: Berger, Judy M (DFG)
Subject: FW: PERMIT: Fish Resource Permit SF2012-151 (Brady/HDR-Susitna River above Devil's Canyon-local Fish)

Hi Judy,
Thanks for the chat. Now you have my email address so if you think of anything, feel free to shoot me an email. ☺
I'll let you know how our sampling goes upon my return...

ERIN CUNNINGHAM

HDR Alaska, Inc.
Fisheries Biologist

2525 C Street, Suite 305 | Anchorage, AK 99503
907.644.2115
erin.cunningham@hdrinc.com | hdrinc.com

From: Piorkowski, Robert J (DFG) [mailto:robert.piorkowski@alaska.gov]
Sent: Monday, May 14, 2012 2:01 PM
To: Brady, James; Cunningham, Erin E.
Cc: Ivey, Samuel S (DFG); Lewis, Bert A (DFG); Bethe, Michael L (DFG); Daigneault, Michael J (DFG); DFG, FMPD Permit Coordinator (DFG sponsored); Boyle, Larry R (DFG)
Subject: PERMIT: Fish Resource Permit SF2012-151 (Brady/HDR-Susitna River above Devil's Canyon-local Fish)

Dear James:

Please find attached your ADF&G Fish Resource Permit (SF2012-151). You need to read this permit carefully not only to understand what you are authorized and required to do but also to check for mistakes that must be corrected immediately by contacting us. If your plans are modified later on (e.g. personnel changes, larger than expected collections, different sampling locations, etc), contact us as soon as you know so that an amendment to your permit can be prepared and issued in time to avert disruptions to planned field work. Failure to abide by permit requirements or to amend your permit when conditions change are permit violations that can result in a citation and/or loss of your permit.

Please be sure that you and all authorized personnel carry a copy of the permit while conducting collecting activities.

A report detailing all collections for this permit is due on or before January 31, 2013. Please use the ADF&G data submissions form for this task. If you do not have the opportunity to utilize your permit, please submit a letter or email stating that the permit was not used. A telephone message is not sufficient.

Please use the subject line in all future correspondence regarding this permit--thanks

Wishing you success with your project,

Bob Piorkowski

Bob Piorkowski-Ph.D.
Fish Resource Permit Program
(907) 465-6109
Robert.Piorkowski@alaska.gov