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OFFICE OF ENERGY PROJECTS

Project No. 14241-000–Alaska
Susitna-Watana Hydroelectric Project
Alaska Energy Authority

Betsy McGregor
Environmental Manager
Alaska Energy Authority
813 West Northern Lights Boulevard
Anchorage, AK 99503

Reference: Determination on Requests for Study Modifications and New Studies – Susitna-Watana Hydroelectric Project

Dear Ms. McGregor:

Pursuant to 18 Code of Federal Regulations (C.F.R.) § 5.15 of the Commission's regulations, this letter contains the determination on requests for modifications to the approved study plan to support an application for Alaska Energy Authority's (AEA) Susitna-Watana Hydroelectric Project. The determination is based on the study criteria set forth in sections 5.9(b), 5.15(d) and (e) of the Commission's regulations, applicable law, Commission policy and practice, and staff's review of the record of information.

Background

Pursuant to the Commission's Integrated Licensing Process (ILP), AEA proposed 58 studies in its proposed study plan filed on July 16, 2012, covering various resources to develop the project application. Forty-four of the studies were approved in the initial Study Plan Determination issued on February 1, 2013; the remaining studies were approved on April 1, 2013. The initial study report (ISR) for all studies was due February 1, 2014.

On January 6, 2014, AEA filed a request for an extension of time to file its ISR from February 1, 2014, to June 3, 2014, and to postpone most second-season studies until 2015 due to the state's fiscal limitations. The Commission granted AEA's request on January 28, 2014. The Commission also granted requests by several stakeholders to postpone the required ISR meeting until October 16, 2014.

AEA filed its ISR on June 3, 2014. In several filings in September 2014, AEA supplemented the record with 30 technical memoranda. Given the unexpected filings and volume of new material contained in the technical memoranda, the Commission modified the ILP plan and schedule to require two sets of ISR meetings: one in October 2014 to

discuss the June 3 filings and another meeting in January 2015 to discuss the technical memoranda. AEA held the October meetings, but on December 31, 2014, AEA requested that the Commission hold the ILP in abeyance until further notice because the Governor of Alaska had suspended discretionary spending on the proposed project, preventing AEA from proceeding with the ILP and holding the required January 2015 meetings. AEA's request was granted on January 8, 2015.

On July 6, 2015, the Governor's office authorized AEA to proceed with the ILP up to the Commission's determination on requested study plan modifications and/or the need for new studies. On August 26, 2015, AEA filed a revised process plan and schedule along with a request that the Commission lift the abeyance and proceed with the ILP accordingly. In its August 26 filing, AEA proposed to supplement the ISR filed on June 3, 2014, and the technical memoranda filed on various dates in September 2014 with additional data it had collected in 2014. AEA also proposed to file a document that would serve as a "roadmap" covering each of the approved studies that included: (1) a status report on study implementation; (2) indication of those sections of the ISR that were being updated with new study results; (3) a cross-reference to any pertinent technical memoranda and reports; and (4) the remaining steps to complete the study plan.[1]

On October 27, 2015, Commission staff lifted the abeyance but deferred approval of the proposed revision to the process plan and schedule pending review of the "roadmap" to determine if it would, in combination with the rest of AEA's filings, reasonably function as an ISR as required by the Commission's regulations. On November 6, 2015, AEA filed the "roadmap" entitled ISR, part D. In addition, between November 4 and November 25, 2015, AEA filed 29 "implementation reports" and 10 "study completion reports" describing in detail the methods, variances, and analyses conducted since the filing of the June 2014 ISR.

Because of the significant gap in the ILP process and substantial amount of new information, Commission staff modified AEA's process plan and schedule on December 2, 2015, requiring AEA to hold the ISR meetings March 21–25, 2016, stakeholders to file requests for study modifications and new studies by June 23, 2016, and AEA to file responses by August 22, 2016. AEA held the ISR meetings on March 22–24 and 29–30, 2016, and filed a meeting summary on April 25, 2016.[2]

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[1] Subsequent to the filing of ISR, part D, AEA filed errata to the completion report for study 9.7 (*Salmon Escapement*) on February 23, 2016.

[2] Subsequent to filing of the ISR meeting summary, on May 17, 2016, AEA filed an implementation report for study 13.5 (*Cultural Resources Study*), and on October 24, 2016, it filed a completion report for study 5.5 (*Baseline Water Quality Study*), a technical memorandum for study 7.5 (*Groundwater Study*), three technical memoranda for study 8.5 (*Fish and Aquatics Instream Flow Study*), an implementation report and memorandum for studies 9.5 (*Study of Fish Distribution and Abundance in the Upper Susitna River*) and 9.6 (*Study of Fish Distribution and Abundance in the Middle and*

On August 4, 2016, Governor Walker filed a letter requesting that the Commission proceed to the issuance of a Commission staff determination on requests to modify or add to the list of approved studies for the project, and thereafter, place the ILP in abeyance because the state would be "closing down" the project. The Governor also requested that the process plan be modified to give AEA an additional 20 days to respond to the "voluminous" comments and study requests filed on AEA's study report. On August 26, 2016, Commission staff confirmed it would proceed to the completion of the study plan modification determination and granted AEA an additional 20 days to file its responses (due September 11, 2016). AEA filed its responses to the study plan modification requests on October 24, 2016.

Comments

Comments on the study reports and meeting summary, including requests for study modifications and new studies, were filed by Commission staff, the National Marine Fisheries Service (NMFS); the National Park Service (NPS); the U.S. Army Corps of Engineers (Corps); the U.S. Fish and Wildlife Service (FWS); the State of Alaska[3]; Cathy Teich; the Copper Country Alliance; the Hydropower Reform Coalition; the Natural Resources Defense Council (NRDC); Rebecca Long; Charlie and Linda Rutledge; the Susitna River Coalition et al.;[4] the Talkeetna Community Council, Inc. (Talkeetna Community Council); The Nature Conservancy; and the Willow Area Community Organization. AEA filed reply comments on October 24, 2016. Jan Konigsberg and Rebecca Long filed comments in support of several of the modifications recommended by the parties listed above.

A number of the comments received do not specifically request modifications to the approved studies and are therefore not addressed herein. For example, some of the comments address the presentation of data; provide additional information; recommend protection, mitigation, and enhancement measures; address ongoing and future consultation; request information that was included in the study report; request information that AEA subsequently provided in its reply comments or agreed to provide in future filings; or request additional information collection contingent on the results of ongoing studies. In addition, several commenters request additional analyses that would be provided in the license application or in the Commission's environmental document, but do not describe how the study should be modified to provide the analyses. This determination only addresses comments that are clearly new requests for study

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Lower Susitna River), and a supplement to the completion report for study 9.9 (*Characterization and Mapping of Aquatic Habitats Study*).

[3] Submitted by the Alaska Department of Natural Resources on behalf of the State of Alaska Agencies, including the Departments of Fish and Game, Environmental Conservation, Natural Resources, and Health and Social Services.

[4] Representing the combined comments of the Susitna River Coalition, Talkeetna Community Council, Alaska Survival, Talkeetna Defense Fund, Alaska Center, Trout Unlimited, and Wild Salmon Center.

modifications or additional studies. This determination does not address requests for study modifications or additional studies that have been addressed in previous Commission determinations.

Study Plan Determination

Pursuant to section 5.15(d) of the Commission's regulations, any proposal to modify a required study must be accompanied by a showing of good cause and must include a demonstration that: (1) the approved study was not conducted as provided for in the approved study plan, or (2) the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way. As specified in section 5.15(e), requests for new information gathering or studies must include a statement explaining: (1) any material change in law or regulations applicable to the information request; (2) why the goals and objectives of the approved study could not be met with the approved study methodology; (3) why the request was not made earlier; (4) significant changes in the project proposal or that significant new information material to the study objectives has become available; and (5) why the new study request satisfies the study criteria in section 5.9(b).

As indicated in appendix A, the requested modifications to 17 studies (5.5, 5.6, 5.7, 6.6, 7.6, 8.5, 9.5, 9.6, 9.8, 9.9, 9.12, 10.8, 10.16, 12.5, 12.7, 15.7, and 15.9) are approved in part. The requested modifications to 18 studies (6.5, 7.5, 7.7, 8.6, 9.7, 9.11, 9.13, 9.14, 9.16, 9.17, 10.5, 10.6, 10.9, 10.14, 10.15, 12.6, 15.6, and 15.8) and the new study request for a terrestrial invertebrate survey are not approved. The specific modifications to the studies and the bases for modifying or not modifying the study plan are explained in appendix B (Requested Modifications to Approved Studies) and appendix C (Requested New Studies). Commission staff considered all study plan criteria in section 5.9 of the Commission's regulations.

Please note that nothing in this determination is intended, in any way, to limit any agency's proper exercise of its independent statutory authority to require additional studies.

ILP Held in Abeyance

AEA has requested that the ILP be held in abeyance with no proposed timeframe for a process re-start. Because AEA is considering an application for an original license for the Susitna-Watana Project, there is no statutory or regulatory deadline for filing a license application. Therefore, how quickly an original project progresses through the ILP essentially depends on how long it takes the applicant to collect the necessary information, and delays in collecting the information in-effect place an ILP in abeyance.

If AEA decides to move forward with developing a license application, AEA may request that the ILP be re-started. Because a process re-start will require the Commission to expend a significant amount of additional staff resources which could affect the processing of other cases, such a request must include a showing that the State of Alaska has a firm commitment to the project. At that time, to the extent that AEA's proposal has not changed and the information has not become stale, AEA would not need to repeat the

already-completed ILP steps. However, the Commission may also at that time require additional scoping and modifications to the approved study plan.

If you have any questions, please contact David Turner at (202) 502-6091, or via e-mail at david.turner@ferc.gov.

Sincerely,

Terry L. Turpin
Director
Office of Energy Projects

Enclosures: Appendix A – Summary of Determinations on Requested Modifications to Approved Studies and New Studies
Appendix B – Staff's Recommendations on Requested Modifications to Approved Studies
Appendix C – Staff's Recommendations on Requested New Studies

cc: Mailing List, Public Files

APPENDIX A

SUMMARY OF DETERMINATIONS ON REQUESTED MODIFICATIONS TO APPROVED STUDIES AND NEW STUDIES

Requested Modifications to Approved Studies[5] (see appendix B for discussion)

Study	Recommending Entity	Adopted	Adopted in Part	Not Adopted
Baseline Water Quality Study (study 5.5)	NMFS, FWS, Susitna River Coalition et al		X	
Water Quality Modeling Study (study 5.6)	NMFS, FWS, Susitna River Coalition et al		X	
Mercury Assessment and Potential for Bioaccumulation Study (study 5.7)	NMFS, FWS		X	
Geomorphology (study 6.5)	NMFS, FWS, Susitna River Coalition et al.			X
Fluvial Geomorphology Modeling Below Watana Dam Study (study 6.6)	NMFS, FWS, Rebecca Long, Susitna River Coalition et al., Talkeetna Community Council		X	
Groundwater Study (study 7.5)	NMFS, FWS, Susitna River Coalition et al			X

[5] The following studies are not addressed in this document because no specific study modification requests required resolution: 4.5 (*Geology and Soils*); 9.10 (*Future Watana Reservoir Fish Community and Entrainment*); 9.15 (*Analysis of Fish Harvest in and Downstream of Susitna-Watana Project Area*); 10.13 (*Bat Distribution and Habitat Use*); 10.17 (*Population Ecology of Willow Ptarmigan in Game Management Unit 13*); 10.18 (*Wood Frog Occupancy and Habitat Use*); 10.19 (*Evaluation of Wildlife Habitat Use*); 11.5 (*Vegetation and Wildlife Habitat Mapping in the Upper and Middle Susitna Basin*); 11.6 (*Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam*); 11.9 (*Invasive Plant Study*); 13.5 (*Cultural Resources Study*); 13.6 (*Paleontological Resources Study*); 14.5 (*Subsistence Resources Study*); 16.5 (*Probable Maximum Flood Study*); and 16.6 (*Site-specific Seismic Hazard Study*).

Study	Recommending Entity	Adopted	Adopted in Part	Not Adopted
Ice Processes in Susitna River Study (study 7.6)	NMFS, FWS, NPS, Teich, Konigsberg		X	
Glacier and Runoff Changes Study (study 7.7)	NMFS, Susitna River Coalition et al., Natural Defense Council			X
Fish and Aquatics Instream Flow Study (study 8.5)	NMFS, FWS, The Nature Conservancy		X	
Riparian Instream Flow Study (study 8.6)	NMFS			X
Study of Fish Distribution and Abundance in the Upper Susitna River (study 9.5)	NFMS, FWS		X	
Study of Fish Distribution and Abundance in the Middle and Lower Susitna River (study 9.6)	NMFS, FWS		X	
Salmon Escapement Study (study 9.7)	NMFS, FWS			X
River Productivity (study 9.8)	NMFS, FWS		X	
Characterization and Mapping of Aquatic Habitats (study 9.9)	NMFS, FWS		X	
Study of Fish Passage Feasibility at Watana Dam (study 9.11)	NMFS, FWS			X
Study of Fish Passage Barriers in the Middle and Upper Susitna River and Susitna (study 9.12)	NMFS, FWS		X	
Aquatic Resources Study within Access Alignment, Transmission Alignment, and Construction Area (study 9.13)	Long			X
Genetic Baseline Study for Selected Fish Species (study 9.14)	NMFS, FWS			X
Eulachon Run Timing, Distribution, and Spawning in the Susitna River (study 9.16)	NMFS, FWS			X
Cook Inlet Beluga Whale Study (study 9.17)	NMFS			X

Study	Recommending Entity	Adopted	Adopted in Part	Not Adopted
Moose Distribution, Abundance, Movements, Productivity, and Survival (study 10.5)	Susitna River Coalition et al.			X
Caribou Distribution, Abundance, Movements, Productivity, and Survival (study 10.6)	Susitna River Coalition et al., Rebecca Long			X
Distribution, Abundance, and Habitat Use by Large Carnivores (study 10.8)	Susitna River Coalition et al.		X	
Wolverine Distribution, Abundance, and Habitat Occupancy (study 10.9)	Susitna River Coalition et al.			X
Surveys for Eagles and Other Raptors (study 10.14)	FWS			X
Waterbird Migration, Breeding, and Habitat Use Study (study 10.15)	FWS			X
Landbird and Shorebird Migration, Breeding, and Habitat Use Study (study 10.16)	FWS		X	
Recreation Resources Study (study 12.5)	Willow Area Community Organization, The Nature Conservancy, Talkeetna Community Council, Inc., NPS		X	
Aesthetic Resources Study (study 12.6)	The Nature Conservancy, NPS, Long			X
River Recreation Flow and Access Study (study 12.7)	Willow Area Community Organization, The Nature Conservancy, Talkeetna Community Council, Inc., NPS		X	
Social Conditions and Public Goods and Services Study (study	Willow Area Community			X

Study	Recommending Entity	Adopted	Adopted in Part	Not Adopted
15.6)	Organization, Talkeetna Community Council, Long, The Nature Conservancy			
Transportation Resources Study (study 15.7)	Willow Area Community Organization, Talkeetna Community Council, Long		X	
Health Impact Assessment Study (study 15.8)	Willow Area Community Organization, Talkeetna Community Council, Long			X
Air Quality Study (study 15.9)	Long		X	

Requested New Studies (see appendix C for discussion)

Study	Recommending Entity	Approved	Approved with Modifications	Not Required
Terrestrial Invertebrate Study	Copper Country Alliance			X

APPENDIX B

STAFF'S RECOMMENDATIONS ON REQUESTED MODIFICATIONS TO APPROVED STUDIES

Model Integration and Evaluation of Operational Scenarios

The majority of the comments filed on Alaska Energy Authority's (AEA) various studies express doubt about how well the various models AEA proposes to use will predict the complex and interrelated facets of the Susitna River ecosystem and if the data collected thus far support model development. In most cases, the commenters argue that AEA has not shown that the models will accurately represent environmental conditions and predict physical processes (e.g., flows, ice formation, groundwater/surface water interaction) under exiting conditions and various project operational scenarios but do not provide specific alternatives to the proposed models.

The National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (FWS) argue that a focused effort to integrate the various models required to achieve the stated study objectives and recommended a new study—Integrated Modeling and Decision Support System**.**

Given the overarching concern, we address the concept of model verification, validation, and integration below. We address any specific recommendations for modeling changes under the applicable studies.

Background

The approved study plan includes several studies with the goals of collecting data and developing mathematical models to represent environmental conditions (including surface water, groundwater, geomorphology, water quality, ice processes, fish habitat, and riparian vegetation development) in the Susitna River under the existing condition and under various operational scenarios. In many cases, results from some models provide inputs to other models. For example, hydraulic modeling provides depth and velocity predictions that will be used in the sediment model to predict where sediment deposits or scour would occur.

The approved study plan requires AEA to develop a decision support system to evaluate project effects on Susitna River environmental resources under various alternative operating scenarios. The decision support system will be used to focus attention on those indicator attributes that the technical working group (TWG) believes are the highest priority in evaluating the relative desirability of alternative operating scenarios with respect to natural resources. When discussion of alternatives focuses on only a few remaining scenarios, those final scenarios will be evaluated using the larger data set of habitat indicators to ensure that environmental effects are consistent with the initial analyses.

Indicator variables will be selected in collaboration with the TWG. The decision support system will be initiated in collaboration with the TWG after the initial results of the various habitat modeling efforts are available in the updated study report (USR). AEA intends to develop the decision support system after the USR and prior to developing its license application to assist in evaluating various operating scenarios in the license application.

Model Integration and Decision Support System

Requested Study Modification

NMFS, FWS, the National Park Service (NPS), The Nature Conservancy, and The Susitna River Coalition, Talkeetna Community Council, Alaska Survival, Talkeetna Defense Fund, Alaska Center, Trout Unlimited, and Wild Salmon Center (collectively Susitna River Coalition et al.) recommend modifying the various aquatic and physical habitat studies (e.g., geomorphology, water quality, groundwater, ice processes, instream flow) to show how AEA will integrate modeling results from each of these studies and then develop a decision support system that clearly explains how it will evaluate the various operational scenarios. The commenters argue that the level of detail regarding how the studies will be integrated and used are poorly defined; therefore, these efforts should be developed as part of a new study that fully describes model integration and the decision support system now. Some of the commenters also state that a validated decision support system must be completed prior to conducting any additional field work or modeling.

The commenters believe that this additional information is needed to provide assurance that the models will be sufficient to evaluate project effects.

Comments on Requested Study Modification

AEA states that model integration is already part of the approved study plan and that preliminary model results for all models will be provided in the USR. AEA argues that section 8.5.4.8.1 of the approved study plan requires that the decision support system be completed after all the models are completed and the preliminary results are available and presented in the USR. AEA adds that it described its approach to model integration at the riverine modeling meetings on November 13–15, 2013, and April 15–17, 2014. Therefore, AEA disagrees that a new study plan describing its proposed model integration and decision support system is necessary.

Discussion and Staff Recommendation

NMFS and FWS variously characterize their requests for model integration as a comment, recommendation, or modification to the *Fish and Aquatics Instream Flow Study* (8.5), *Water Quality Modeling Study* (5.6), *Fluvial Geomorphology Modeling Study* (6.6), *Groundwater Study* (7.5), *Ice Processes Study* (7.6), and *Riparian Instream Flow*

Study (8.6). In essence, NFMS and FWS repackage their concerns to also argue for a new study focused on explaining how AEA will integrate the various study results and use them in their decision making. Because their requests are objectives of existing studies and the agencies do not provide any specific method to achieve these objectives (other than further collaboration to design a study framework, schedule, and milestones for the detailed work by appropriate specialists), we view the requests as study modifications that do not rise to the level of a new study.

Section 8.5.4.8.1 of the approved study plan requires AEA to describe the linkages and integration between studies and models in the USR. Section 8.5.4.8.1 also requires initiating the development of the decision support system in collaboration with the TWG after the initial results of the various modeling efforts are available. Because model development is incomplete and ongoing and AEA already provided a general (albeit limited) illustration of which studies and models will provide inputs to other models (see revised study plan [RSP], figure 8.5.10) as well as an example of the type of decision support system it intends to develop (see RSP, table 8.5-21), we see no need to require AEA to further develop this information at this time (section 5.9(b)(4)). We expect that preliminary modeling and integration results, when presented in the USR, will address whether or not additional data collection or alternative methods of analysis are needed to inform our analysis and develop license requirements (section 5.9(b)(4)). This reasonable and stepwise approach is both consistent with the approved study plan and with accepted practices for completing and integrating aquatic and physical process models within the context of a hydroelectric licensing case (section 5.9(b)(6)). For these reasons, we do not recommend requiring AEA to develop a new study plan that describes how it will integrate models or further develop its decision support system at this time.

Model Verification, Validation, and Uncertainty

Requested Study Modification

NMFS, FWS, NPS, Susitna River Coalition et al., and The Nature Conservancy recommend that AEA provide a detailed description of model calibration and validation for each model prior to integrating the models and providing preliminary model results. The commenters note that in some cases model validation and calibration is not complete. In other cases, while AEA states calibration and validation is complete, it does not provide statistical results of calibration (e.g., residual average, residual standard deviation, R^2) or validation to substantiate its claims of model validation. The commenters also state that AEA calibrated some models using all available data and did not set aside data for model validation, prohibiting AEA from completing the objective of model validation in the future and through accepted scientific procedures.

Additionally, NMFS and FWS recommend that AEA conduct an uncertainty analysis of the results of the various models so stakeholders can fully understand the limitations of each model. Susitna River Coalition et al. recommend that AEA expand its consideration of uncertainty to clearly identify all sources of uncertainty and to clearly

show a method for tracking and accounting for all sources of uncertainty. The Nature Conservancy recommends that AEA develop a framework to define and communicate uncertainty of the integrated model approach.

Comments on Requested Study Modifications

AEA states that these components of model development and refinement are already part of the approved study plan and that it will include in the USR a complete description of how each model was configured, parameterized, calibrated, and validated, as well as a description of sensitivity analyses and uncertainties in key model parameters (see section 2.4.1.5.3, page 255 of AEA's initial study report [ISR] reply comments) as recommended by the Commission in its June 23, 2016 comments on the ISR. AEA states that the models it is developing vary in methods, scope, predictive capability, and complexity, and that these components of model development have not been completed because the models have not been completed. AEA states that, if the preliminary modeling results (including calibration, validation, or uncertainty) identify data gaps, it will collect additional data to address such gaps during the next study season.

Discussion and Staff Recommendation

Because AEA agreed to provide a complete description of how each model was configured, parameterized, calibrated, and validated, as well as sensitivity analyses and any uncertainties in key model parameter values, the issues of model verification raised by the commenters have been adequately addressed (section 5.9(b)(4)) and will enable us to determine if the models are sufficient to inform our analysis and develop license requirements (section 5.9(b)(4)). Therefore, we do not recommend any modifications to the study plan to address model calibration, validation, or uncertainty at this time.

Evaluation of Operational Scenarios

Requested Study Modification

NMFS, FWS, and The Nature Conservancy state that it is not clear what operational scenarios AEA plans to include in the USR and recommend that AEA develop the scenarios now in consultation with stakeholders. NMFS, FWS, and Susitna River Coalition et al. also recommend that the additional operational scenarios that AEA will develop and evaluate include the run-of-river scenario, required by the Commission, as well as other valid scenarios. NMFS and FWS recommend that AEA provide more details on the flows and ramping rates under the intermediate load-following scenario and model water surface elevations with the latest version of the Open Water Flow Routing Model under this scenario.

Comments on Requested Study Modifications

AEA indicates that it will include the preliminary results for all models required by the approved study plan for existing conditions and at least one operating scenario in the USR. AEA states that following the USR, it will develop other alternative operational scenarios such as intermediate load following and run-of-river in consultation with stakeholders and evaluate the selected scenarios in the draft license application.

Discussion and Staff Recommendation

AEA's proposal to include the preliminary modeling results in the USR for the existing condition and one potential operational scenario[6] will be sufficient to determine if the modeling efforts will be adequate to inform our analysis and develop license requirements (section 5.9(b)(4)). In addition, AEA's proposal to develop additional operational scenarios in consultation with stakeholders at a later point in time prior to filing its draft license application is a reasonable approach that is consistent with accepted practices for providing modeling results within the context of a hydroelectric licensing case (section 5.9(b)(6)). Therefore, we see no reason to require AEA to develop or evaluate other operational scenarios at this time.

Study 5.5 – Baseline Water Quality

Background

The purpose of study 5.5 is to establish baseline water quality conditions in the Susitna River to inform an assessment of the anticipated effects of the proposed project on water quality in the Susitna River Basin. The study objectives are to: (1) document historical water quality data and combine it with new data generated from this study for use in study 5.6; (2) add three years of stream temperature and meteorological data to augment existing data; (3) characterize surface water physical, chemical, and bacterial conditions in the Susitna River within and downstream of the proposed project area; (4) measure baseline metals concentrations in sediment and fish tissue for comparison to state criteria; and (5) perform a pilot thermal imaging assessment of the Susitna River between Talkeetna and Devils Canyon.

[6] At the March 2016 ISR meetings, AEA indicated that the USR would contain preliminary modeling results for the existing condition and the maximum load following scenario.

Additional Data Collection and Stand-alone Study Report

Requested Study Modifications

For various reasons NMFS, FWS, and Susitna River Coalition et al. request that AEA collect additional water chemistry, water quality, water temperature and groundwater data.[7] NMFS and FWS note that: (1) the majority of water chemistry data collected in 2013 were rejected because of quality control problems; (2) continuous water temperature data were not collected downstream of Project River Mile (PRM) 90, and no data were collected for several reaches, 30 miles in length or longer upstream of PRM 90; (3) the quality of the 2013 groundwater data are questionable; and (4) water quality samples were not collected in situ with sediment samples to support baseline metal concentration and mercury methylation modeling. In addition, FWS requests that AEA craft the *Study 5.5 Baseline Water Quality Study Completion Report* into a stand-alone document that provides information about quality control and describes analytical methods and how data will be used in modeling.

Comments on Requested Study Modifications

In general, AEA disputes the need for additional data collection, stating that the data collected satisfy the study objectives. AEA states it collected mainstem continuous temperature data from six collection sites downstream of PRM 90 in 2012, 2013, and 2014.

AEA also contests the assertion by NMFS and FWS that no water temperature data were collected in 30+ mile-long reaches upstream of PRM 90. AEA indicates continuous water temperature data were collected from 30 sites in 2012, 28 sites in 2013, and 36 sites in 2014, which resulted in continuous water temperature data from 36 of the planned 37 sites; only spot measurements were collected at the 37th site. AEA further states that deployment of the temperature probes every year from 2012 through 2014 provides a compilation of data that results in a complete, one-year period-of-record of continuous water temperature data for each of the 36 sites. AEA also argues that a data gap between PRM 145.6 to 209.2 does not exist as asserted by the commenters because continuous temperature data were collected at four sites within this reach at PRMs 152.2, 152.3, 152.7, and 183.1 in 2012. AEA states that the data collected from 2012 to 2013 are sufficient for the model calibration and validation to reproduce observed conditions.

AEA further states the data collected under study 5.5 are already provided in the *Study 5.5 Baseline Water Quality Study Completion Report* and associated technical memorandum. Therefore, developing a stand-alone study report as requested by FWS is not necessary. In addition, AEA states that the volume of information being gathered is

[7] Susitna River Coalition et al. only request additional water temperature data collection.

substantial; therefore, it would not be practical or cost-effective to reproduce information already provided to the Commission and licensing participants. AEA also states that the information will be comprehensively synthesized, and a discussion of the ecological significance of changes in water quality will be presented in exhibit E of the license application.

Discussion and Staff Recommendations

The approved study plan defines the geographic scope of the study to be from PRM 19.9 to 235.2, and requires AEA to monitor water quality and water temperature approximately every 5 miles in between. AEA established a total of 38 water quality and continuous water temperature monitoring sites from PRM 19.9 to PRM 235.2 that include 7 tributary and 31 mainstem monitoring stations. On average, the distance between mainstem stations was 7.4 river miles, with a maximum distance of 27.9 and minimum distance of 0.3 river mile, respectively. Of the 31 mainstem stations, AEA established six continuous water temperature monitoring stations downstream of PRM 90.[8] Upstream of PRM 90, the maximum distance between mainstem stations was 16.3 river miles (PRM 209.2 to PRM 225.5). The maximum distance between continuous water temperature and water quality monitoring stations was 15.4 river miles between PRM 152.7 and PRM 168.1 and 38.3 river miles between PRM 187.2 and PRM 225.5, respectively. Given these distances between study stations, we find that AEA deviated from the study plan because the spacing between stations was often considerably greater than approximately every 5 miles. At this point, we cannot determine if this deviation prevents achieving study objectives for the reasons discussed further below.

While AEA has collected a substantial amount of water quality data, we cannot determine if that data fulfill the study objectives and are adequate for our analysis of environmental effects (section 5.9(b)(4), (5), (6) and (7)) because the data have not been compiled and presented in a form that clearly describes existing conditions. For example, some tables within the reports do not indicate what water quality metric is being presented (e.g., the range as minimum to maximum or the range of means or medians); some figures appear to include aberrant measurements, such as those recorded when the temperature loggers were dewatered; and the reported data often only include examples of the collected data. Further, while the majority of the data collected are available in spreadsheets on the project's licensing website,[9] we find: (1) the spreadsheets are unclear with regard to which water quality data points passed AEA's quality assurance project plans and were deemed acceptable for further analysis; (2) the titles of spreadsheets do

[8] The six continuous water temperature monitoring stations downstream of PRM 90 are located at PRM 19.9, PRM 29.9, PRM 33.6, PRM 59.9, PRM 87.8, and PRM 88.3.

[9] http://gis.suhydro.org/reports

not always match the corresponding spreadsheet dictionary;[10] (3) spreadsheet column headings often do not match dictionary column heading descriptors; (4) column headings within some spreadsheets have column headings masked and/or missing; and (5) historical data are not included in the dataset. Consequently, we find that in its current state, the data are largely unusable, and we are also unable to determine the adequacy of the data to characterize the baseline water chemistry, water quality, water temperature, and groundwater of the Susitna River.

However it would be premature to require AEA to essentially redo the study as requested by the commenters until AEA is afforded the opportunity to clarify its results. Therefore, we recommend AEA consolidate, present, summarize, describe, and discuss all data collected as a part of study 5.5 into a coherent and comprehensive stand-alone study report as FWS requests. Specifically, we recommend AEA include in the report: (1) the continuous temperature data plotted by month; (2) the historical, continuous, and grab sample temperature and the baseline water quality data in tables with maximum, minimum, mean, and median values for each month; (3) a list of the water quality data that were collected concurrently (i.e., in the same location) with the sediment samples; and (4) the results of the quality control/quality assurance plan for each water quality parameter. The quality control/quality assurance assessment should include the detectability, precision, accuracy, completeness, representativeness, and comparability, as applicable, for each water quality parameter sampled.

While compiling the data into a stand-alone water quality report will require some effort, putting the data in a usable format is significantly less costly than recollecting much of the data (section 5.9(b)(7)). Upon receipt of the stand-alone water quality report, we should be in a position to evaluate the adequacy of the baseline water data collected pursuant to study 5.5.

Regarding the Whole Fish Analysis for Metals and Methylmercury

Requested Study Modifications

NMFS states AEA only sampled metals in fish fillets. NMFS states metals tend to concentrate in internal organs, and sampling of fish fillets only may underestimate the concentration of metals and mercury being transferred to piscivorous wildlife such as beluga whale. Therefore, NMFS requests that AEA specify which fish tissues were collected for metals analysis and that AEA grind up and analyze the whole fish in the future.

[10] Spreadsheet dictionaries are separate Microsoft Word documents that list and define column headings for each corresponding spreadsheet.

We note that NMFS made this same comment and request on the *Mercury Assessment and Potential for Bioaccumulation Study* (5.7). As a result, we address NMFS comment and request for whole fish tissue sampling below in study 5.7.

Thermal Infrared Remote Sensing

Requested Study Modifications

NMFS and FWS state that the thermal infrared remote sensing (TIR) is important to understand groundwater-surface water interactions. NMFS and FWS state that the 2014 TIR effort in the Lower River was abandoned, and AEA's goals were not met. As a result, NMFS requests AEA perform TIR in the Lower River as originally planned in 2014.

Comments on Requested Study Modifications

AEA states the TIR data collection was a pilot study, and the study plan only requires AEA to collect TIR in the Middle River (see section 5.5.4.9 of the RSP). AEA also states that because the pilot TIR study was successful, it voluntarily extended the TIR data collection to the Lower River. AEA adds that even though conditions in 2013 for TIR data collection were not ideal, it was able to collect data over 73 percent of the Lower River and planned to collect TIR data for the remaining portion of the Lower River in 2014. However, after further analysis of the collected TIR data, winter and aerial photographs, and aerial videography data, AEA abandoned its plan to collect the 2014 TIR data because the objectives for studies 7.5, *Groundwater,* and 8.5, *Fish and Aquatic Instream Flow* can be met without it.

Discussion and Staff Recommendations

An objective of the study plan is to, "Perform a pilot thermal imaging assessment of a portion (between Talkeetna and Devils Canyon) of the Susitna River" to provide data to support studies 7.5 and 8.5 (see section 5.5.1 and 5.5.4.9 of the RSP). The study plan also specifies that, "In coordination with the instream flow and fish studies, a determination will be made as to whether thermal imaging data will be applicable and whether or not additional thermal imagery will be collected during the 2013 field season to characterize river temperature conditions." Because the 2012 TIR data collection was highly successful, AEA volunteered to collect additional TIR data within the Lower River in 2013 and collected TIR data covering 73 percent of the lower river. We expect that this information, coupled with winter and aerial photographs and videography, will sufficiently characterize groundwater-surface water interactions and meet the objectives and data needs of studies 7.5 and 8.5 (sections 5.9(b)(4) and (6)). We do note, however, that studies 7.5 and 8.5 are ongoing, and pending the results of those studies, we may determine a need for additional data. However, at this time, the collection of the additional Lower River TIR data is not necessary (section 5.9(b)(7)).

Study 5.6 – Water Quality Modeling

Background

The goal of this study is to use the information collected from the study 5.5 to develop a model(s) to evaluate the potential effects of project operations on various physical water quality parameters within the Susitna River Watershed. The study objectives are: (1) implement an appropriate reservoir and river water temperature model for use with past and current monitoring data; and (2) using data from study 5.5, model water quality conditions in the Susitna River and the proposed Watana Reservoir, including (but not necessarily limited to) temperature, dissolved oxygen (DO), fine suspended sediment and turbidity, chlorophyll-a, nutrients, ice (in coordination with study 7.6), and metals.

To date, AEA has completed data collection but spatial configuration and calibration of the Environmental Fluid Dynamics Code (EFDC) model is ongoing. Based on initial modeling results, AEA is not proposing to extend the EFDC modeling below PRM 29.9.

Model Layer Thickness for the Proposed Watana Reservoir

Requested Study Modifications

The EFDC model uses a 20-layer vertical grid of variable cell thickness to predict reservoir water temperatures. NMFS and FWS request that AEA show that the use of a 20-layer vertical grid with a bottom layer thickness of 25 meters accurately predicts reservoir thermal stratification. Both NMFS and FWS assert that the proposed thickness of the bottom layer (in the 20-layer vertical grid) is too high (82 feet [25 meters]) to accurately capture the reservoir stratification. Both agencies request that AEA support its findings by providing "adequate simulations under ice free conditions" using both the 20-layer and 40-layer model configurations.

Comments on Requested Study Modifications

AEA disagrees with the need to conduct additional modeling to prove the accuracy of the 20-layer model. AEA argues that while the reservoir as represented by the EFDC model is hypothetical, EFDC results using 20 layers adequately demonstrate the dynamics of stratification and overturn with seasons. In support, it argues that the reservoir hydrodynamic module in EFDC was tested using the 1984 historical inflow and a corresponding load following outflow. The model successfully simulated the one-year period (1984) with an approximately 45-meter variation in pool level during that period. Preliminary temperature simulation for ice-free conditions and the proof of concept results demonstrate the model's ability to represent the dynamics of reservoir stratification and overturn. AEA further argues that a 40-layer configuration is impractical because EFDC becomes extremely unstable with increased layers (resolution)

and can quickly crash at a higher resolution. AEA argues that the current 20-layer configuration is fully capable of simulating the operation of the proposed intake shutters from multiple elevations (multiple intake ports) to determine optimal drawdown levels and shutter operation to minimize impacts on downstream temperatures. Therefore, the 40-layer configuration is not necessary to meet the study objectives or assess project impacts. AEA estimates it would cost $800,000 to develop and run the model using a 40-layer resolution for each of the four operating scenarios because of the model's complexity (i.e., model instability, longer model run time).

Discussion and Staff Recommendation

While details of the EDFC model simulation are not provided in the ISR, the reported results indicate the 20-layer model will provide sufficient resolution to describe temperature stratification within the reservoir (sections 5.9(b)(4) and (6)). As described in the ISR, grid layer thicknesses ranges from 8.2 feet (2.5 meters) at the surface to 82 feet (25 meters) at the bottom, with the coarsest resolution occurring in the deeper parts of the reservoir. Because the bottom layers of the model would simulate the proposed reservoir's hypolimnion, and temperatures within a hypolimnion typically remain uniform during the stratification period, a 40-layer finer scale resolution would not likely produce results for the deepest parts of the reservoir that differ significantly from the 20-layer coarser scale model output. Thus, the information that would be obtained from running a finer scale 40-layer model is not needed to evaluate potential project effects and would not be worth the cost (sections 5.9(b)(6) and (7)). Therefore, we do not recommend modeling reservoir water quality with a 40-layer model.

Lower Susitna River Modeling

Requested Study Modifications

The approved study plan requires AEA to model water quality to the upstream extent of the Susitna River estuary at PRM 19.9. However, in the technical memo filed in September 2014, AEA determined that project operational effects on temperature are minimal downstream of PRM 29.9, and given similar results associated with changes in DO, AEA chose to limit the downstream extent of water quality modeling efforts to PRM 29.9. FWS and NMFS contend that the water quality modeling effort should extend downstream of PRM 29.9 to the Susitna River braided estuary. However, NMFS and FWS recognize that the extension would significantly increase model complexity and require the collection of detailed bathymetry to establish a solid hydraulic, geomorphologic, and water quality database. NMFS also states that if EFDC is not appropriate for the highly braided river transitioning into an estuary, then a different modeling technique could be selected and applied. For example, NMFS and FWS state that the approach could be simplified by using the EFDC model, open water model, and the Physical Habitat Simulation (PHABSIM) model during the ice-free period, as needed, to assess project-related impacts in this downstream reach.

Comments on Requested Study Modifications

AEA asserts that NMFS and FWS have not established "good cause" for expanding the geographic scope of the water quality modeling study. AEA states that continuing the model downstream would add little additional understanding of project effects because project-related changes in water quality at PRM 29.9 are minimal and would further attenuate downstream of PRM 29.9 (Tetra Tech, 2014). In addition, the cost of continuing the EFDC modeling an additional 10 miles downstream to PRM 19.9, as originally proposed in the study plan, is estimated to be on the order of $1,000,000, including data collection, calibration of the EFDC model, and running at least four operational scenarios, with little gain in terms of quantifying project effects.

Discussion and Staff Recommendation

There is little basis for extending water quality modeling efforts downstream of PRM 29.9 as requested by NMFS and FWS. Neither agency justifies why modeling should be extended downstream. In addition, the modeling and analyses to date indicate that potential project effects on water temperature, DO, and total suspended solids downstream of PRM 29.9 would be minimal. As reported in Tetra Tech (2014), the EFDC hydrodynamic and water quality models simulated two, three-year periods, 1974–1976 and 1979–1981 under historic pre-project conditions and proposed post-project conditions, based on the maximum load following scenario (which prioritizes power production). Model runs account for extreme conditions, wet year and dry year, and include multiple years to account for the effect of inter-annual variation in climate. The EFDC model predicted water temperature at the dam site, PRM 125, PRM 60, and PRM 29.9. In a "worst-case" post-project scenario model run (water withdrawal from the reservoir surface), the model predicted 2 to 3 degrees Celsius (°C) warmer water temperature at PRM 125 in late summer and fall. At PRM 60, the post-project temperature is approximately 1 to 2°C higher in the early fall. At PRM 29.9, pre- and post-project water temperatures differ by less than 1°C. Correlation plots and regression results of the worst-case operational scenario indicate that post-project temperatures at PRM 29.9 would exceed pre-project temperatures by approximately 1 percent. Similarly, DO concentrations are expected to remain near saturation throughout the river, and total suspended solids may be reduced by 1 percent at PRM 29.9. These results indicate that extending detailed modeling downstream of PRM 29.9, which would have a significant cost, would have little value; therefore, we do not recommend water quality modeling between PRM 29.9 and the estuary (sections 5.9(b)(4) and (7)).

Study 5.7 – Mercury Assessment and Potential for Bioaccumulation

Background

The goals of the mercury assessment studies are to assess the potential for mercury methylation within the proposed reservoir, the concentrations of methylmercury (MeHg)

that might occur, and whether a mechanism exists for transferring that MeHg to wildlife. The study objectives are: (1) summarize available and historic mercury information for the Susitna River Basin; (2) characterize the baseline mercury concentrations of the Susitna River and tributaries through collection and analyses of vegetation, soil, water, sediment porewater, sediment, piscivorous birds and mammals, and fish tissue samples; (3) use available geologic information to determine if a mineralogical source of mercury exists within the inundation area; (4) map mercury concentrations of soils and vegetation within the proposed inundation area to define where mercury methylation may occur; (5) use the water quality model from study 5.6 to predict where in the reservoir conditions (pH, DO, turnover) are likely to be conducive to MeHg formation; (6) use modeling to estimate MeHg concentrations in fish; (7) assess potential pathways for MeHg to migrate to the surrounding environment; (8) coordinate study results with other study areas, including fish, instream flow, and other piscivorous bird and mammal studies; (9) use the Phosphorus Release Model to predict peak MeHg levels in fish tissue, regardless of the outcome of the Harris and Hutchinson and EFDC models; and (10) identify likely riverine receptors (i.e., biota living downstream of the reservoir that may be exposed to elevated MeHg concentrations produced in the reservoir and discharged to the river) as part of the predictive risk analysis.

AEA collected water quality data to determine baseline mercury levels (as well as other parameters) in 2013 and 2014. AEA, however, reported that 2013 total mercury did not meet laboratory quality assurance acceptance limits; therefore, the data would not be used in calibrating the riverine water quality EFDC model. AEA conducted mercury sampling in sediment and biota in 2013 and 2014. However, no fur or feather samples were collected for MeHg analysis in 2013, no bird/feather samples were collected in 2014, and only a limited number of fur samples were collected in 2014. AEA proposes no additional sampling of fish species that are either not present or present in only very low numbers (humpback whitefish, rainbow trout, and stickleback). It also proposes to defer any further mercury analysis of wildlife tissue until the predictive modeling (reservoir and riverine EFDC models) and potential for mercury transfer from the aquatic environment to the terrestrial environment using pathway analysis models have been completed and evaluated. If piscivorous bird sampling is determined to be necessary, blood and feather samples from nestlings of the four target species (bald eagle, common loon, and red-breasted and common mergansers) will occur based on each species' abundance within the study area and the likelihood of obtaining usable samples.

Additional Year of Water Quality Sampling

Requested Study Modifications

NMFS and FWS recommend that AEA collect an additional year of data to replace the 2013 data because they consider the 2013 data invalid due to inadequate quality. FWS further requests AEA describe how the 2013 data were reviewed for quality in a full comprehensive summary of the analytical issues encountered and how

these issues were addressed. Additionally, NMFS and FWS disagree with the use of a total phosphorous (TP) correction factor for the mercury data based on suspended solids loads. They comment that the 2013 data set has multiple issues and the use of a correction factor does not address all of the data quality issues (i.e., blank contamination, preservative contamination, cooler temperature, filter breakthrough, and shipment breakage). NMFS and FWS contend that sampling for mercury should ultimately provide at least two years of representative data to document baseline conditions.

Comments on Requested Study Modifications

AEA opposes conducting an additional year of water quality sampling because mercury sampling has been completed in accordance with the approved study plan; conducting another year of sampling would cost $300,000 to $400,000.

AEA notes that the approved study plan requires one year of sampling. Because all of the 2013 data for mercury from surface waters were discarded, it recollected mercury samples in 2014, and the combination of 2013 (dissolved) and 2014 (total) mercury concentrations were sufficient to achieve the study objectives.

AEA states that the concerns regarding the use of the TP correction factor in relation to mercury samples is apparently misunderstood. As explained in study 5.5, a correction factor was used only for the 2014 TP results. All 2013 TP data were rejected for failure to meet quality assurance acceptance limits, and the TP correction factor was not applied to the 2013 TP results. In contrast, to replace the total mercury results in 2013 that were rejected, samples were recollected in 2014, and the resulting data all met quality assurance standards. Therefore, a correction factor was not developed for or applied to the 2014 total mercury data. Another separate document (a comprehensive summary of the analytical issues encountered) is not necessary to meet study objectives.

AEA also disagrees that all of the 2013 mercury samples were either rejected or had significant quality control issues as FWS asserts. Mercury data results for MeHg and dissolved mercury met acceptance limits from all media collected in 2013 (surface water, porewater, sediment, and fish tissue). Only 2013 total mercury data were rejected for not meeting quality assurance acceptance limits in laboratory performance analysis. The rejected 2013 total mercury data will not be used in calibrating the riverine water quality EFDC model. The 2014 total mercury results, which were collected to replace the rejected 2013 total mercury samples, met QA acceptance limits and will be used in calibrating the reservoir and riverine water quality model.

Discussion and Staff Recommendation

AEA collected a dataset that constitutes one complete year of water quality data, which is consistent with the requirements of the approved study plan. As we said in the initial study determination, “the combined use of a mechanistic water quality model such as EFDC, an empirically-based fish tissue model from other hydroelectric impoundment

studies in North America, and the predictive risk analysis based on established TRVs (toxicity reference values) is a reasonable and accepted approach (section 5.9(b)(6)) for evaluating the anticipated level of mercury input to both the reservoir and ecological receptors after initial reservoir filling, and should provide the information necessary to evaluate project effects (section 5.9(b)(4)), and develop any future license conditions to address mercury methylation." Further, AEA provided the information requested by the agencies on data quality and the use of data in the models, in previous reports. A comprehensive summary covering the same subject matter is not necessary (sections 5.9(b)(4) and (7)). Until the results of the predictive models are provided, it is premature to require AEA to collect additional mercury samples from surface waters.

Additional Mercury Sampling of Piscivorous Birds and Mammals

Requested Study Modifications

FWS says that wildlife samples are an important component to understanding mercury transport and bioaccumulation and that because no samples were collected in 2014 or thereafter, insufficient sampling of these biota has occurred to date. Therefore, it recommends that AEA collect samples of tissues from piscivorous birds and mammals to document baseline mercury concentrations in wildlife. FWS also recommends that AEA identify the pathway analysis/modeling methods and decision criteria to be applied to the 2013 and 2014 aquatic sample data that will be used to decide if additional sampling of piscivorous wildlife is needed. FWS believes that current fish sampling, showing some mercury concentrations in fish, indicates that mercury transfer to wildlife could occur.

FWS also recommends an expedited sampling plan to discuss the findings of the 2013 sampling season, a description on how these data are informing the 2014 field season, and identification of the additional methods and collection details associated with the potential 2015 wildlife sampling efforts. Although FWS calls this a "new study," in its comments, FWS states that "additional" sampling should be conducted, so this is essentially asking for a plan modification to do additional sampling.

Comments on Requested Study Modifications

AEA opposes additional sampling, which FWS has recommended multiple times and notes that FWS has not established "good cause" for the modification nor has it demonstrated the study was not implemented as provided by the approved study plan. AEA argues that its approach of deferring additional wildlife tissue sampling until completion of the pathways/modeling analysis is adequate to achieve the study objectives and avoids hiring unnecessary specialty contractors to collect tissues from protected species (e.g. bald eagles). AEA adds that contrary to the FWS's statement, none of the EFDC water quality model predictions will be based on 2013 rejected water quality mercury sampling. Data used to support water quality modeling include 2013 data that meet quality assurance standards and 2014 replacement data that meet quality assurance

standards. AEA also argues that it described the pathways analysis in the *Mercury Assessment Pathways Analysis Technical Memorandum*. AEA does not specifically respond to FWS's "new study request" (an expedited sampling plan) but has stated throughout its reply comments that additional mercury sampling should not be required.

Discussion and Staff Recommendation

The pathway analysis/modeling should show whether or not bioaccumulation of mercury would occur in fish tissue and thus be available to piscivorous birds and mammals. If that modeling indicates bioaccumulation would occur, additional tissue sampling may be needed. This reasonable and stepwise approach is both consistent with the approved study plan and with accepted modeling practices (section 5.9(b)(6)).

We are not recommending an expedited sampling plan at this time. However, if the pathway analysis indicates that additional sampling should occur, we recommend that AEA develop a sampling plan in consultation with NMFS and FWS. Although AEA has presented some information on how it might collect additional samples from wildlife (using specialty subcontractors), additional details are warranted.

Additional Fish Sampling

Requested Study Modifications

AEA sampled fish species in the project area for mercury levels by collecting muscle tissue (fillets) from a target of 10 fish per species. NMFS, however, recommends that AEA analyze entire fish for mercury rather than fillets, because birds and larger fish do not fillet fish before consuming them. Choosing to sample only fish fillets to analyze for mercury may not correctly represent the bioaccumulation of mercury. NMFS also states that the study plan calls for the collection of 7 to 10 fish per species, which was not achieved for all species, and that 10 fish per species should be collected. NMFS further states that no mercury or MeHg tissue concentrations were reported in the ISR, although some raw data are available for review in laboratory reports attached to the data validation reports.

Comments on Requested Study Modifications

AEA states that sampling the entire fish is unnecessary and contrary to established sampling practice. The highest concentrations of MeHg are found in muscle tissue of adult predatory fish (Frenzel, 2000), which are the likely group to show more immediate effects from release of mercury during filling of the reservoir and bioaccumulation several years following (see RSP, section 5.7.4.6.1). Other studies in Alaska measuring mercury concentrations in fish (ADEC, 2012) focused on fillets and have been used to compare results with those collected from the Susitna River Basin (study 5.7, study implementation report [SIR], section 6.7). AEA also says it has collected a representative sample of each fish species, including the different sizes (age classes) present at a site,

and the minimum number of fish per species was collected, consistent with the study plan, except for species rarely found in the area. All results will be reported in the USR.

Discussion and Staff Recommendation

AEA followed standard scientific practices for mercury sampling in fish (using fillets) and met the minimum sample size for primary species occurring in the project area. The approved study plan requires collecting 7 to 10 fish per species for mercury analysis, and AEA collected a minimum of 7 fish for the most common species. Sample sizes were not achieved only for species that rarely occur in the project area. NMFS does not provide a good justification for why up to three more fish per species would substantially improve the data set. Therefore, we neither recommend additional sampling to achieve 10 fish per species nor redoing the study by sampling whole fish (sections 5.9(b)(6) and (7)).

Use Available Geologic Information to Determine if a Mineralogical Source of Mercury Exists within the Inundation Area

Requested Study Modifications

NMFS recommends that AEA map mercury concentration data collected from stationary sources, such as native soils and vegetation, and investigate any hotspots. Protocols for these location-specific investigations should be developed. NMFS states that mercury hotspots do occur in nature; however, these hotspots could be contained if their location was known prior to filling the reservoir. Because simple averages obscure the spatial patterns, the presentation of the data is insufficient for a full understanding of mercury conditions in the project area. The current study proposes to submit the data in tables, and no provision exists for follow-up work if hotspots are detected. NMFS says the study has not yet been conducted as provided for in the approved study plan.

Comments on Requested Study Modifications

AEA states that identifying co-occurrence of elevated mercury concentrations in multiple samples to indicate a "hotspot" of concern is not an objective of the approved study. Sampling of sediment, water, and fish tissue is designed to be representative of conditions throughout the Susitna River Basin and does not include multiple sites that are clustered. Multiple samples taken from an individual site were replicates intended to measure precision of the sampling routine and to account for site variability. The sampling designs for each of the media (i.e., water, sediment, and fish) were specifically for use in describing baseline conditions, calibrating the EFDC water quality model, and providing input to the Harris and Hutchinson Model and the Phosphorus Release Model. Mercury "hotspots" do not occur in the terrestrial portion of the proposed inundation area as reflected by uniformity of mercury concentrations in vegetation and soil sampling results. Interpretation and use of the data in completing the pathway analysis/modeling

will be performed in the next year of study and presented in the USR. This will include mapping of areas where mercury levels may be higher.

Discussion and Staff Recommendation

Mapping existing "hotspots" is not part of the approved study plan. AEA's modeling efforts, however, would indicate which parts of the reservoir may be most susceptible to increases in mercury levels, based on predicted water quality conditions. This should show where in the reservoir higher mercury levels may develop and will be sufficient for our environmental analysis (sections 5.9(b)(5)); therefore, no modification to the study plan is warranted at this time.

Include Likely Riverine Receptors as Part of the Predictive Risk Analysis

Requested Study Modifications

Objective 10 of the RSP requires AEA to identify likely riverine receptors (i.e., biota living downstream of the reservoir that may be exposed to elevated MeHg concentrations produced in the reservoir and discharged to the river) as part of the predictive risk analysis. NMFS recommends analyzing the mercury pathways to quantify how mercury might bioaccumulate to toxic levels in Cook Inlet beluga whales (CIBW), which is a federally listed species. However, because NMFS does not want CIBW approached or sampled, alternative means would need to be investigated. NMFS notes that these whales live from 30 to 40 years, and mercury bioaccumulation has already been found in some individuals. Even a small increase in mercury in prey species could significantly elevate levels found in CIBW. NMFS believes the study was not conducted as approved because the highest organism in the food chain has not been considered.

Comments on Requested Study Modifications

AEA asserts that NMFS has not established "good cause" for the requested modification. AEA believes the potential for CIBW to consume prey contaminated by bioaccumulation of mercury due to the presence and operation of the project is small. AEA states that export of mercury downstream of the reservoir is unlikely because of the shallow nature of the river and its highly oxygenated water quality. AEA also believes the potential for the CIBW food source (salmon) to have bioaccumulated mercury is minimal because adult salmon spend most of their lives at sea (outside any exposure to mercury levels associated with the project), and juvenile salmon would unlikely bioaccumulate mercury because of their relatively short time in the river and their primary food source (zooplankton and insects). AEA states that extending the modeling downstream of PRM 29.9 (where CIBW are more likely to occur) would cost $1 million, while additional mercury sampling of water and aquatic organisms would cost $200,000.

Discussion and Staff Recommendation

The approved study requires AEA to assess the potential risks to ecological health from mercury bioaccumulation in the vicinity of the reservoir and downstream river reaches using a pathway assessment and predictive risk analyses, including likely downstream riverine receptors. The proposed riverine receptor will be fish, which are the CIBW prey. NMFS does not describe what "alternative means" are possible for its requested analysis of CIBW. However, because the potential for project-related mercury bioaccumulation in the CIBW prey (fish) appears low, and the pathway analysis/modeling should verify whether or not bioaccumulation of mercury would occur in fish tissue and thus be available to CIBW, we do not recommend including CIBW as a riverine receptor or modeling downstream of PRM 29.9 (sections 5.9(b)(5), (6) and (7)). However, if AEA's modeling indicates that mercury bioaccumulation will occur in fish in the lower Susitna River, we recommend that AEA assess whether CIBW could be subject to mercury bioaccumulation, based on a more detailed literature review of the distribution and food habits of CIBW in the lower Susitna River.

Comments on Methodology

Requested Study Modifications

NMFS recommends that water quality samples be taken from both banks and the center of the river at the proposed dam site.

Comments on Requested Study Modifications

AEA says the location of water quality sampling at the dam site adequately characterizes conditions using the existing sampling protocol. The Susitna River at PRM 187.2 was well-mixed, and the samples collected on one bank were representative of water quality conditions. No information supports the need to sample multiple points across the river.

Discussion and Staff Recommendation

Sampling multiple points across the well-mixed river is not necessary. Therefore, we do not recommend requiring AEA to collect the additional samples (sections 5.9(b)(6) and (7)).

Study 6.5 – Geomorphology

Background

The purpose of the study is to characterize the geomorphology of the Susitna River and to evaluate the potential project effects on the geomorphology and dynamics of the river by predicting the trend and magnitude of geomorphic response. The study

objectives include: (1) geomorphically characterizing the project-affected river channels and floodplain; (2) collecting sediment transport data to support characterization of Susitna River sediment supply and transport; (3) determining sediment supply and transport in Middle and Lower Susitna River segments; (4) assessing geomorphic stability and/or change in the Middle and Lower River; (5) characterizing the surface area versus flow relationships for riverine macrohabitat types over a range of flows in the Middle Susitna River segment; (6) conducting a reconnaissance-level geomorphic assessment of potential project effects on the Lower and Middle River; (7) conducting a phased characterization of the surface area versus flow relationships for riverine macrohabitat types in the Lower River; (8) characterizing the proposed Watana Reservoir geomorphology and changes resulting from conversion of the channel / valley to a reservoir; (9) assessing large woody debris (LWD) transport and recruitment, their influence on geomorphic forms, and effects related to the project; (10) characterizing geomorphic conditions at stream crossings along access road/transmission line alignments; and (11) integrating with study 6.6 to develop estimates of project effects on the creation and maintenance of the geomorphic features that comprise important aquatic and riparian macrohabitats.

Sediment Supply, Transport, and Mass Balance

Requested Study Modifications

NMFS and FWS request that AEA provide an assessment of uncertainty in daily suspended load and bed load estimates for both reported values and annual load estimates, which may require additional suspended load and bed load measurements to help define the variability of sediment transport rates at a station over time. NMFS and FWS indicate that (1) limited sampling was conducted to characterize sediment transport near the dam site, (2) the methods used to collect the sediment samples and number of samples collected underestimate some size fractions, and (3) additional samples are needed to define accurate bed load transport rates and assess error. Susitna River Coalition et al. request that AEA collect additional bed load sediment data at Tsusena Creek and other important tributaries. Susitna River Coalition et al. assert, without elaboration, that tributary sediment transport measurements collected to date are insufficient to model sediment transport at tributary mouths throughout the Middle River or evaluate the post-project effects on sediment transport and habitat quality.

NMFS and FWS also request that AEA (1) clarify which size classes of sediments are considered to be supply-limited and what is meant by sediment transport equilibrium, (2) assess the feasibility of using a morphological approach to estimating long-term bed load transport rates in the Middle and Lower River, and (3) use information from the *Glacial Runoff Changes Study* (7.7) to help predict changes in sediment supply. NMFS and FWS state that supply limitations for certain grain sizes under existing conditions and under with-project conditions are unknown, that a morphological approach to estimating sand and gravel bed load along the Middle and Lower River would provide an

independent check on short-term bed load measurements that integrates a longer time frame, and that tributaries with significant land area covered in ice need to be evaluated to predict how sediment supply would change in response to climate change.

NMFS states that based on channel structure, tributary inputs, and changes in stream gradient, the geomorphic reaches are too coarse to be of much value and that the Middle and Lower River should have been divided into finer geomorphic reaches. Because many of the studies stratify data collection efforts by geomorphic reach, the poorly defined reaches affect the quality of the data collected by those studies and will subsequently affect the accuracy of the various modelling efforts.

Comments on Requested Study Modifications

With respect to variability in sediment samples, AEA indicates that historical (1980s) and current (2012–2014) sediment sampling results agree. AEA notes that any variability in measured transport rates is physically realistic, and the uncertainty of the sediment sampling results will be evaluated in accordance with the approved study plan. Thus, AEA concludes that the collected sediment data are representative of site conditions and will be sufficient to develop relationships for estimating transport rates and sediment loads.

Regarding the need to conduct additional measurements in tributaries to the Susitna River, AEA explains that sediment loading from ungaged tributaries in the Middle River will be accounted for by using an appropriate bed material transport function along with the surveyed tributary channel geometry and measured bed material gradation to calculate sediment yield rating curves. The channel geometry has been surveyed, and bed material gradation samples have been collected for each of the 22 tributaries. AEA notes that the bed material in the tributary channels are generally not mobilized except for during very high flow conditions. AEA states that conducting field work at a large number of tributaries during a brief period of sufficiently high flow is not feasible.

AEA also states that the analyses to identify which specific grain size classes are supply limited is being conducted according to the approved study plan. AEA indicates that most channel changes influencing sediment transport rates and load are from bank erosion rather than bed elevation changes, and that the requested morphological approach to estimating long-term transport rates and load will not effectively describe this process. AEA also indicates that contribution from glacial runoff to the Middle River is shown to be relatively small, and increases in sediment supply from downstream tributaries with glaciers would offset reductions from reservoir sediment trapping.

AEA notes that it vetted the geomorphic reach delineations in the Upper, Middle, and Lower River segments throughout their development with the various licensing participants and that it has developed a four-level hierarchically tiered classification system that recognizes variability within the individual geomorphic reaches to meet the

scale-dependent needs of the project components. The basis of the delineations as well as the reach delineations themselves are robust and serve the study objectives.

Discussion and Staff Recommendation

AEA's approach to estimating sediment loads from individual ungaged tributaries in the Middle River is appropriate because it's the best they can feasibly do given the physical and logistical limitations to sampling sediment load in these tributaries. In any event, the approach is sufficient for estimating the sediment loads. More specifically, in accordance with the approved study plan, AEA will conduct a sensitivity analysis for the one-dimensional (1-D) and two-dimensional (2-D) bed evolution modeling (BEM) efforts by varying key input parameters, including substrate gradations and the magnitude and gradations of inflowing sediment loads. Provided that AEA uses a physically realistic and representative range of parameter values for substrate gradation and load within a site or reach, these methods should adequately characterize the sensitivity of uncertain sediment gradation and load on 1-D and 2-D modeling results. Based on the results reported thus far, the historical and current sediment sampling data should be adequate to develop relationships for estimating transport rates and sediment loads. Therefore, we do not recommend requiring AEA collect additional suspended and bed load data at this time.

In accordance with the approved study plan, AEA will identify if, and to what degree, supply limitation occurs within the specific grain size fractions (i.e., cobble, gravel, sand, bed load, suspended load, and wash load) based on unique rating curves developed for each fraction. Based on our review of the study reports, the morphological approach requested by NMFS and FWS would not effectively describe long-term transport rates and load. AEA adequately demonstrated that large increases in sediment concentration from glacial surges would have relatively small effects on sediment supply to the reservoir. Therefore, we do not recommend requiring AEA clarify which size classes of sediments are considered to be supply-limited, use a morphological approach to estimating long-term bed load transport rates, or consider increases in sediment concentration from glacial surges.

We agree with AEA that geomorphic reach delineations in the Upper, Middle, and Lower River segments were repeatedly vetted throughout their development with the various licensing participants, and that the hierarchically tiered classification system adequately accounts for variability in hydrology, geomorphic form and process, sedimentology, and macrohabitat within and between geomorphic reaches necessary to meet the scale-dependent study objectives. Therefore, we do not recommend requiring AEA to reconsider geomorphic reach delineations.

Middle and Lower River Geomorphic Change and Habitat Relationships

Requested Study Modifications

To fulfil the habitat area versus flow relationship objective, NMFS, FWS, and Susitna River Coalition et al. recommend that AEA take aerial photographs to document the lateral extent of the Middle River, as well as the Lower River from the Yentna confluence upstream to Talkeetna, at the range of flows that AEA intends to discharge from the dam, including low flows. They note that to date, the photos are at a single flow (i.e., 12,500 cubic feet per second [cfs]).

Susitna River Coalition et al. recommend that AEA collect at least one full year of stage-discharge information for the Middle River, stating that this information is needed to properly evaluate how much lateral habitat would be available under with-project flows in the Middle River and how post-project changes in flow would affect off-channel habitats. They state that the lack of baseline aerial imagery or stage-discharge relationships for current winter flow conditions limits AEA's ability to evaluate proposed project habitat changes from current conditions throughout the Middle River. FWS and NMFS state that modeling would be more accurate if it can be calibrated with aerial photographs and/or a stage-discharge relationship over the appropriate flow range, and that post-project low-flow conditions would be outside the range for hydraulic model calibration.

NMFS and FWS request that AEA provide details about how the lateral channel changes along the Middle River will be predicted if the effective discharge calculation is abandoned. NMFS and FWS state that the subroutine to HEC-RAS 5.0 that AEA proposes to use is focused on main channel aggradation and incision, but the slower and shallower lateral margins of the Middle River channel are more important to spawning adults and juveniles compared to the center of the main channel. NMFS and FWS also recommend AEA characterize watershed-scale landforms and geomorphic processes in the Susitna watershed and in Middle River tributaries. NMFS and FWS state that information about present and expected future sediment sources and supply is necessary to interpret changes in the mainstem Susitna River channel.

Comments on Requested Study Modifications

AEA proposes to deviate from the approved study plan, which specifies that the habitat area versus flow relationships will be developed from aerial photography obtained at a range of flow rates, by developing habitat area versus flow relationships using 1-D and 2-D modeling to quantify the aerial distribution of habitat conditions in the main channel and lateral habitats of the Middle River. The variance includes model calibration and validation over the range of flows being modeled. Two-dimensional model results quantifying habitat area versus flow in the Focus Areas will be extrapolated to the remainder of the Middle River using the habitat mapping developed in the *Characterization of Aquatic Habitats Study* (9.9), water surface elevations from the 1-D

model, and the breaching flow elevation surveys to be conducted throughout the Middle River. AEA states that the use of a combined 1-D and 2-D modeling approach provides the ability to analyze macrohabitat area over a larger range of flows than the originally proposed aerial photography and is compatible with the application of the 2-D BEM in Focus Areas over the 50-year analysis period. AEA states that it has developed a robust set of data to calibrate the 1-D HEC-RAS model as well as the 2-D hydraulic model and BEM, including individual point-in-time water surface elevations and continuous water surface elevation recordings throughout the Middle River. Therefore, AEA argues that its proposed method will meet this study plan objective and avoid the additional expense ($400,000 to $600,000) associated with the NMFS, FWS, and Susitna River Coalition et al.'s proposed modification.

AEA asserts that collecting additional aerial photos from the Yenta confluence to Talkeetna to document the river's lateral extent at the range of flows that are likely post-project is not needed to achieve the study objectives. AEA argues that the approved study plan only requires collecting the aerial photos if habitat area versus flow relationships are going to be developed to support the *Fish and Aquatics Instream Flow Study* (8.5). Based on its 2012 assessment of the project's potential to alter stage changes, AEA concludes that a detailed assessment of project effects similar to that being conducted in the Middle River was not warranted in the Lower River, and aerial photography at two additional discharges would not be collected.

Contrary to NFMS and FWS's assertion that AEA will not be calculating the effective discharge and therefore will not be able to model lateral channel changes along the Middle River, AEA points out that the study still includes an analysis of effective discharge, but because the sediment rating curve in the Middle River would be significantly altered by reservoir sediment trapping, effective discharge is a poor predictor of changes in channel geometry. The modeling approach uses the 1-D BEM to determine the reach scale effects (aggradation, degradation, bed material size change in the main channel) of the project and then applies the 2-D BEM to assess project effects on a finer scale, including in lateral habitats.

AEA argues that the watershed-based approach recommended by NMFS and FWS is not as effective at characterizing the project-affected river channel and floodplain as the methods being used, results in greater uncertainty, and is not necessary to meet the study objectives. AEA argues that it is addressing sediment supply from the larger tributaries based on sediment transport data and estimation of bed load and that it will qualitatively address sediment load in smaller tributaries that do not deliver substantial quantities of sand and finer sediment.

Discussion and Staff Recommendation

Based on our review of the study reports, we conclude that the large changes in channel geometry that occurred over the last 30 years indicate that additional aerial photography would not be useful in predicting geomorphological changes under post-

project conditions in the Middle and Lower River. AEA's approach to develop habitat area versus flow relationships in the Middle River using 1-D and 2-D modeling results is reasonable and consistent with accepted practices for providing modeling results within the context of a hydroelectric licensing case (section 5.9(b)(6)) and should meet the intent and objectives of the study plan, provided the models are calibrated and validated over the range of flows being modeled, including low flows under with-project conditions. Until AEA completes the required modeling, it is premature to require study modifications. Therefore, we do not recommend requiring AEA to acquire additional aerial photography of the Middle and Lower River or collect additional stage-discharge information for the Middle River.

We note that in addition to assessing lateral channel changes along the Middle River through analysis of effective discharge consistent with the approved study plan, AEA will also analyze lateral channel changes at the reach scale using the 1-D BEM and at a finer scale within Focus Areas using the 2-D BEM. The combination of these approaches should adequately describe potential changes to mainstem and lateral habitats under with-project conditions; however, we cannot determine if additional effort will be necessary until AEA completes its required modeling.

We agree that an assessment of present and expected future sediment sources and supply rates based on watershed-scale landforms and geomorphic processes would not be as effective as the methods in the approved study plan, would involve more uncertainty, and is not necessary to meet the study objectives. Therefore, we do not recommend requiring AEA characterize watershed-scale landforms and geomorphic processes.

Downstream Project Effects

Requested Study Modifications

NMFS and FWS request that AEA "conduct a literature review in the manner of Kellerhals and Gill (1973) in order to provide case histories related to downstream effects of dams in northern climates." They recommend that AEA use a range of methods gleaned from the literature review, case histories from past projects, and site-specific analysis to provide a reconnaissance level assessment of project effects on geomorphology. NMFS and FWS state that the conceptual frameworks used by AEA to assess project effects in the Susitna River are too generalized, do not allow an assessment of project effects, and that a more site-specific approach utilizing experience from past projects is likely to provide more useful information. NMFS and FWS also request that if AEA does not intend to use existing conditions to represent the future without the project, that AEA provide a detailed explanation of predicted changes in channel morphology over the next 100 years and evaluate the uncertainty of the predictions.

NMFS and FWS also request that AEA use information from study 6.5 to test and validate the accuracy of long-term (decadal) predictions from the numerical models and use geomorphic methods to make predictions of channel response to changes in sediment

supply and discharge to provide independent checks on the model predictions. NMFS and FWS believe that to fully integrate fluvial geomorphology modeling with other geomorphic studies, it is necessary to define the most important processes that need to be represented in the models and provide independent predictions of project effects as a means of testing and validating model predictions and helping develop realistic assessments of uncertainty.

Comments on Requested Study Modifications

AEA states that an additional literature review is not needed. AEA indicates that it has already conducted a literature review that encompasses the world-wide literature on dams and their downstream effects in northern climates, including the extensively cited results of years of research and observations on the Peace River in Canada. AEA further asserts that evaluating effects based on case studies in analogous river systems is unlikely to result in meaningful and reliable interpretations specific to the Susitna River. AEA indicates that it has provided a preliminary reconnaissance level assessment of potential project effects, which will be revised and refined during future planned elements of the approved study plan and related study integration.

AEA states that study component 2 in the RSP for study 6.6 (section 6.6.4.2) describes the approach for future with- and without-project comparisons, in which existing conditions are the starting point and the selected 50-years of with- and without-project hydrology and sediment supply are used as input to evaluate geomorphic change. Uncertainty will be evaluated as part of study 6.6 (RSP section 6.6.4.2.2.3).

AEA states that component 11 of study 6.5 and component 3 of study 6.6 were established in the RSP to validate the accuracy of long-term predictions of channel response to changes in sediment supply. AEA's response cites numerous examples where data and field observations and measurements from study 6.5 and other studies were integrated with modeling outputs from study 6.6 to develop an understanding of existing geomorphic conditions and support study 6.6 on the topics of the equilibrium state of the system, key geomorphic processes dictating system behavior, and potential project effects on the geomorphology of the Susitna River.

Discussion and Staff Recommendation

Additional consideration of case histories of the downstream effects of dams in northern climates is not necessary because the approved study plan includes a literature review of the downstream effects of dams as well as a framework to evaluate site-specific effects to the Susitna River. We agree with AEA that evaluating effects to the Susitna River based on effects in analogous river systems is unlikely to result in meaningful site-specific interpretations because of the many local factors influencing river response. Therefore, we do not recommend requiring AEA to conduct a literature review in the manner of Kellerhals and Gill (1973) to provide case histories related to downstream effects of dams in northern climates.

Study component 2 in the approved study plan for study 6.6 describes the approach for assessing geomorphic change during a 50-year model simulation period. The approach involves modeling geomorphic changes under four scenarios, including an existing conditions scenario (without the influence of the project). The results of the existing conditions model run should serve as a baseline against which the results from three with-project scenarios would be compared. Because hydropower licenses are issued for a maximum term of 50 years, simulating geomorphic changes for a 100-year period is not necessary or warranted. Therefore, we do not recommend requiring AEA to predict changes in channel morphology over the next 100 years and evaluate the uncertainty of the predictions.

The approved study plan (component 11 of study 6.5 and component 3 of study 6.6) identifies methods by which AEA will use numerical model simulations and other supporting information to predict channel response to changes in sediment supply and discharge and to address uncertainty, consistent with what is requested by NMFS and FWS. Therefore, we do not recommend requiring AEA to test and validate the accuracy of long-term (decadal) predictions from the numerical models and utilize geomorphic methods to make predictions of channel response to changes in sediment supply and discharge.

Study 6.6 – Fluvial Geomorphology Modeling below Watana Dam Study

Background

The purpose of the study is to model the fluvial geomorphology of the Susitna River. The results of this study will be used in other studies to support evaluation of the aquatic and riparian habitats of the Susitna River. The study objectives include: (1) developing calibrated models to predict the magnitude and trend of geomorphic response to a range of project operation alternatives; (2) applying the developed models to estimate the potential for channel change compared to existing conditions; and (3) coordinating with study 6.5 to integrate model results with the understanding of geomorphic processes and controls to identify potential project effects that require interpretation of model results.

Model Development in the Mainstem Susitna River

Requested Study Modifications

NMFS and FWS request that AEA provide detailed information on the fluvial morphology modeling capabilities of HEC-RAS 5.0.0 (1-D model) and SRH-2D[11] 3.0 (2-D model) to demonstrate the capabilities of both models. NMFS and FWS recommend

[11] SRH-2D is the Bureau of Reclamation's, Sedimentation and River Hydraulics – Two-Dimensional model.

that AEA validate the proposed numerical models by using them to simulate existing case histories of large glacial river systems.

Comments on Requested Study Modifications

AEA argues that it provided information regarding the capabilities of the 1-D and 2-D models in the *Fluvial Geomorphology Modeling (FGM) Approach Technical Memorandum* and the *FGM Development Technical Memorandum*.

Discussion and Staff Recommendation

AEA's description of the 1-D and 2-D modeling capabilities is consistent with the approved study plan. Validating these models by applying them to case studies of analogous river systems is not feasible because the costs of obtaining the large data sets necessary to apply them to other river systems would be great, and the models are built on assumptions and data specific to the Susitna River. Further, such efforts are not likely to result in meaningful or reliable site-specific interpretations to the Susitna River nor confirm their appropriate use in the Susitna River because of the many site-specific factors influencing river response. Therefore, we do not recommend requiring AEA to validate the 1-D model and 2-D model by using the models to simulate existing case histories of large glacial river systems.

Model Development in Tributaries to the Susitna River

Requested Study Modifications

NMFS and FWS request that AEA include a short reach of each tributary as a lateral branch in the 1-D model so that computation of tributary sediment loads considers "with-project" changes in water surface and bed elevations and incorporates dynamic feedback between the tributaries and the mainstem. NMFS and FWS state that reduced mainstem river discharges and stage heights may lead to enlargement of tributary alluvial fans/deltas. NMFS and FWS also state that it is unclear if the proposed tributary modeling approach will describe potential effects because it does not demonstrate dynamic feedback between the mainstem and the tributaries.

Rebecca Long states that use of only one transect to represent the whole Chulitna River confluence may not be scientifically defensible and cites general concerns regarding the accuracy of the bed evolution model for the three rivers confluence at Talkeetna. Although she is not explicit in her request, we interpret her comment as a request for AEA to conduct more bed material sampling at the three rivers confluence.

Comments on Requested Study Modifications

AEA asserts that the request to conduct 1-D modeling in the lower reaches of tributaries does not distinguish the applicability of the approach to tributary channels with

varying size and sediment input. AEA states that under the approved study plan, the 1-D modeling approach in tributaries is being applied to the lower reaches of the Chulitna River and Talkeetna River, the two large tributaries with substantial sediment sources and where interactions between mainstem and tributary sediment sources are more important. AEA argues that it would not be appropriate to apply the requested 1-D modeling approach to answer questions regarding delta evolution in smaller tributaries because in the 1-D reach scale modeling, the relatively small amount of sediment supplied by a tributary is distributed throughout a relatively small wetted area and does not form a delta in the main channel cross section. AEA argues that the tributary delta modeling at 15 Middle River tributaries required in the study plan and successfully demonstrated at Skull Creek is more appropriate.

In response to Rebecca Long, AEA explains that the winter sampling to which she refers is not directly related to estimating bed load in the Talkeetna and Chulitna Rivers, but was conducted for the purpose of comparing bed particle size characteristics at different locations (e.g., bar and island heads and other sites). AEA states that the limited number of bed material samples collected in this vicinity during winter sampling (five surface and subsurface samples on the Chulitna River and five surface and subsurface samples on the Talkeetna River) satisfied the study objective of characterizing variability in bed particle size between the main channel and bar and island heads. Other data have been collected in the vicinity of the Talkeetna and Chulitna Rivers to inform bed load transport analyses.

Discussion and Staff Recommendation

The approved study plan requires 1-D bed evolution modeling in the lower reaches of the Chulitna and Talkeetna Rivers consistent with the NMFS and FWS study modification request. More detailed 2-D modeling of tributary fan development that accounts for dynamic post-project changes in tributary and mainstem water levels and bed levels will occur in the Focus Areas. AEA's approach to assessing potential geomorphic changes in the smaller tributaries was successfully demonstrated at Skull Creek because the results were consistent with its turnover analysis, 2-D bed evolution modeling, and field observations. Because AEA's approach is reasonable in evaluating potential project effects on tributary deltas in the Middle River, we do not recommend modifying its study approach.

Winter surface and subsurface bed material samples in the vicinity of the lower Talkeetna and Chulitna Rivers are sufficient to characterize the variability in grain size between the main channel bed and island heads. Therefore, we do not recommend requiring AEA to collect additional bed material samples or other transect data in this vicinity.

Sediment Delivery Index

Requested Study Modifications

NMFS and FWS request that AEA replace or overhaul the Sediment Delivery Index (SDI) approach to use a more physically based approach to develop a more robust assessment of pre- and post-project accretion rates. NMFS and FWS state that the SDI is too simplistic and only qualitatively assesses changes in accretion rates using data from rivers far removed from the Susitna with fewer ice effects.

Comments on Requested Study Modifications

AEA states that the SDI is based on suspended sediment concentrations and the amount of time features would be inundated, which are the dominant physical drivers of sediment accretion in floodplains. SDI results would be validated based on information available through coordination with study 7.6 and study 8.6, including sediment accretion measurements and observations of inundation during the winter and during breakup.

Discussion and Staff Recommendation

Because the SDI approach is based on the frequency and duration of inundation and the respective sediment concentrations during inundation, it is a reasonable, albeit simplified, proxy for evaluating potential project effects on vertical floodplain accretion across vegetated islands and overbank surfaces within a long reach of river. The model cited in the NMFS and FWS request has not been extensively applied to large glacial river systems analogous to the Susitna River, would require additional parameterization and data collection at considerable cost, and may not provide any more information or greater confidence in post-project accretion rates over and above the SDI approach. AEA is collecting additional data and conducting additional analyses as part of studies 7.6 and 8.6 that can be used to correlate SDI values to measured sedimentation rates and related processes. Therefore, we do not recommend requiring AEA to develop a different approach to assess potential changes in sediment accretion rates.

Downstream Extent of Geomorphic Modeling

Requested Study Modifications

NMFS and FWS request that AEA extend fluvial geomorphologic modeling from PRM 29.9 to the Cook Inlet. They state AEA's decision not to model the Susitna River between PRM 29 and Cook Inlet is not being made in accordance with the approved study plan because decisions about the extent of project effects are being made before the models that predict those effects are fully functional and tested. They also contend that AEA's decision is not supported by current modeling results. NMFS and FWS state that although AEA anticipates that the influence of large tributaries discharging into the Lower River would dissipate the effects of the dam on hydraulics and sediment transport,

the predictions made by the 1-D bed evolution model indicate that the project effects would increase with the distance downstream from the project dam. That is, the largest project effect was predicted to occur in the stream bed at the most downstream reaches that were modeled.

Comments on Requested Study Modifications

AEA states that the approved study plan requires it to use 1-D modeling to characterize existing natural variability and assess whether or not with-project conditions would exceed the range of natural variability and only if that were the case, extend modeling efforts downstream. AEA argues that the modeling results in the vicinity of PRM 29.9 show small with-project changes relative to the natural variability. It further states that modeling downstream of PRM 29.9 is vastly more complex because of more complex channel morphology and tidal boundary conditions, and 1-D modeling would not provide reliable results. For these reasons, it does not propose to extend geomorphic modeling downstream of PRM 29.9.

Discussion and Staff Recommendation

The approved study plan requires AEA to extend the bed evolution modeling below PRM 79,[12] if the results of the 1-D modeling show differences between existing and with-project conditions that are beyond the range of natural variability downstream of geomorphic reach LR-1 (PRM 102.4 to PRM 87.9). The approved study plan does not describe the criteria to be used to determine what constitutes natural variability other than to say that the criteria will be determined in collaboration with the licensing participants. During TWG meetings held in 2013, AEA agreed to model bed evolution down to PRM 29.9 and to extend the study reach below PRM 29.9 if the following criteria, which were vetted with the working group, were met: (1) there was a change in flow at Susitna Station (PRM 29.9) and associated potential for channel width adjustment; (2) there was a change in sediment transport mass (sand and larger materials) over the open-water period; (3) there was a difference in modeled bed elevations represented by channel aggradation or degradation; and (4) there was a change in flow depth and velocity. The evaluation included determining the magnitude of change and the natural variability associated with each of the criteria.

For each of the four decision point criteria, the magnitude of change simulated under the maximum load-following operation scenario was small relative to the range of natural variability under existing conditions, and the range of variability with operational conditions was similar to existing conditions. Alternative operation scenarios would

[12] Some sections of the revised study plan used the River Mile (RM) system from the 1980s Alaska Power Authority project studies, which was replaced by the current Susitna-Watana project river-mile (PRM) system. RM 75 equates to PRM 79.

likely produce less pronounced effects than the maximum load following operation scenario. Therefore, we do not recommend requiring AEA to extend fluvial geomorphologic modeling downstream of PRM 29.9.

Modeling at Three Rivers Confluence

Requested Study Modifications

The Talkeetna Community Council and Rebecca Long request 2-D modeling in the three river confluence area. The Talkeetna Community Council also requests that the Bank Erosion Index (BEI) be applied to the confluence area. The Talkeetna Community Council expresses concern that elevated winter flows under ice conditions proposed in the load following operations model could affect the safety of downstream communities, as well as significant investments in the Talkeetna area; therefore, this area needs to receive adequate attention regarding both specific baseline conditions and potential project-related changes in hydraulics and flooding during open water and under ice.

Comments on Requested Study Modifications

AEA proposes to perform 2-D hydraulic modeling of the three rivers confluence area as modifications to the study plans for study 6.6 (for the open water period) and study 7.6 (for the ice-cover period), but opposes applying the BEI to the confluence area. As proposed by AEA, the modeling for both periods would include a range of flows representing existing conditions on each of the three rivers, coupled with operational flows on the Susitna River, and would provide information on potential project-related erosion and flooding effects for open water and ice-cover conditions. The model for the open-water period would extend from approximately PRM 98.5 to PRM 104.5 on the Susitna River and approximately 3 miles up the Chulitna and Talkeetna Rivers. The open water period hydraulic modeling would use the SRH-2D model for the 2-D area of the confluence and the 1-D HEC-RAS model to establish downstream boundary conditions. Detailed bathymetric, topographic, and hydraulic data would be collected to support development of the 2-D hydraulic model. AEA's proposed modeling of the three rivers confluence area would include with- and without-project flows on the Susitna River combined with the natural range of flows on the Chulitna and Talkeetna Rivers. AEA states that bed evolution modeling is not necessary to address erosion or flooding because these concerns can be evaluated with 2-D hydraulic models. AEA also states that analysis of differences in shear stress and velocity (components of BEI) between the simulations are recommended as appropriate measures of potential bank erosion at the areas of concern. AEA argues that BEI should not be used, however, because study results indicate that bank erosion is more related to ice processes than open water flows.

Discussion and Staff Recommendation

Study results from Focus Area FA-128 (Slough 8A) and elsewhere in the Susitna River indicate that bank erosion in the three rivers confluence is more related to ice processes than open-water flows. Because BEI poorly represents bank erosion in response to changes in open-water flows, we do not recommend applying BEI to the three rivers confluence. AEA's proposed 2-D modeling in this reach will likely provide the necessary information to assess project effects on erosion and flows in this reach. Therefore no further modifications are needed at this time.

Presentation of Model Results

Requested Study Modifications

NMFS and FWS request that AEA present 1-D model results of predicted bed levels in Focus Areas for each year during the 50-year simulation period. NMFS and FWS request that the data be presented in terms of location-specific curves showing time on the x-axis and bed elevation on the y-axis. NMFS and FWS note that the downstream geomorphic effects would usually be most intense near the dam and would progress downstream over time. Near the dam, the rate of morphological changes would be fastest immediately after dam construction, but would slowly decrease over time as the river approaches a new with-project equilibrium. They contend that providing 1-D model results at two fixed points in time (year 25 and year 50) may be reasonable for relative comparison between different scenarios but will not provide a clear picture of how the river would adjust to the imposed with-project conditions and their time scales.

Comments on Requested Study Modifications

AEA agrees that annual simulations over a 50-year timeframe at the geomorphic reach scale is possible using the 1-D BEM and that such simulations will help explain how river reaches adjust to project changes. Therefore AEA proposes to provide the 50-year simulations at the geomorphic scale. However, AEA states that it is not be appropriate to present the data for each Focus Area because the 1-D BEM is not intended for use at the local (e.g., site or transect) scale.

Discussion and Staff Recommendation

Because presenting annual 1-D BEM model results will more clearly demonstrate trends and the trajectory of change over the 50-year simulation period, we recommend AEA present reach-average bed elevation changes. However, we do not recommend requiring AEA to present model results at the site or transect scale because of the physical limitations and uncertainties of 1-D modeling at the local scale.

Model Verification

Requested Study Modifications

NMFS and FWS request that AEA compare the results of the 1-D and 2-D models across common cross sections and for various identical pre- and post-project flow conditions. NMFS and FWS state that 1-D models use a single width-averaged value of a hydraulic parameter (e.g. depth, velocity, shear stress) to represent the entire cross section, which neglects the variability across the channel width. As a result, a disproportionate amount of the total bed load in a cross section is transported along the deepest part of the river channel where velocity and shear stress are normally highest. Susitna River Coalition et al. request that AEA use different data to model sediment transport and design a transparent plan to integrate the transport of LWD and ice processes into the modeling approach. Abt Associates suggests that AEA is inappropriately using total annual runoff as a predictor of annual transport rate rather than computing sediment loads based on the duration and magnitude of flows above a critical discharge threshold. Susitna River Coalition et al. also comment that AEA lacks a defined modeling approach to understand the LWD budget in the Middle River and properly evaluate post-project effects.

Comments on Requested Study Modifications

AEA states that 1-D and 2-D bed load transport models are best suited for different spatial and temporal scales, and it is not necessary or meaningful to compare results from the two approaches. AEA argues that Abt Associates' assertion that annual runoff was used as a predictor of annual sediment transport is incorrect, rather it used hourly discharges as model input for the study. AEA recognizes that the BEMs do not incorporate the transport of LWD, but LWD would be incorporated into the 1-D and 2-D BEMs. Sediment transport under ice cover is known to be very limited and is not a process that is simulated in available 1-D models. Studies 6.6 and 7.6 will be coordinated to evaluate sediment transport potential based on the River1D model results for ice cover conditions, and specific simulations will be designed regarding blockage and breakup surges using 2-D BEM modeling. AEA's inventory and repeat surveys of LWD and log jams within 16 LWD sample areas before and after significant flows, along with the turnover analysis of bank erosion is sufficient to develop a LWD budget and to evaluate potential project effects on LWD. In accordance with the approved study plan, AEA is planning on integrating ice processes and geomorphology modeling.

Discussion and Staff Recommendation

1-D and 2-D sediment transport models are intended to evaluate different temporal and spatial scales; comparison of 1-D and 2-D models results across common cross sections is not appropriate or necessary to meet the study objectives. Therefore, we do

not recommend requiring AEA to compare 1-D and 2-D model results across common cross sections as requested by NMFS and FWS.

AEA's analyses and modeling use appropriate flow data consistent with the approved study plan. Therefore, we do not recommend requiring AEA to use different data to model sediment transport as requested by Susitna River Coalition et al.

In the approved study plan, AEA identifies an approach to evaluating post-project effects on LWD in the Middle River that involves empirical data collection, analysis, and modeling. AEA is also integrating LWD and ice processes into geomorphology modeling as part of the approved study plan as described in the *FGM Approach Technical Memorandum*. Therefore, a new plan is not necessary.

Study 7.5 – Groundwater Study

Background

The purpose of the study is to describe groundwater processes and project effects on those processes. The study objectives relevant to this determination include: (1) synthesizing historical and contemporary groundwater data available for the Susitna River groundwater and groundwater-dependent aquatic and floodplain habitat, including that from the 1980s and other studies; (2) using the available groundwater data to characterize large-scale geohydrologic process-domains/terrain of the Susitna River (e.g., geology, topography, geomorphology, regional aquifers, shallow groundwater aquifers, groundwater/surface water [GW/SW] interactions); (3) assessing the potential effects of Watana Dam/Reservoir on groundwater and groundwater-influenced aquatic habitats in the vicinity of the proposed dam; (4) working with other resource studies to map groundwater-influenced aquatic and floodplain habitat (e.g., upwelling areas, springs, groundwater-dependent wetlands) within the Middle River segment of the Susitna River; (5) characterizing water quality (e.g., temperature, DO, conductivity) of selected upwelling areas that provide biological cues for fish spawning and juvenile rearing, in Focus Areas as part of the Fish and Aquatics Instream Flow Study (Section 8.5); (6) characterizing the winter flow in the Susitna River and GW/SW interactions; and (7) characterizing the relationship between the Susitna River flow regime and shallow groundwater users (e.g., domestic wells).

Refinement of the Groundwater Flow Model

Requested Study Modifications

NMFS and FWS request that AEA evaluate changes in groundwater temperature and DO from proposed project operations. NMFS and FWS note that the temperature and DO content of upwelling groundwater are important factors influencing aquatic habitat and that there appears to be no task or objective in the groundwater study for

evaluating changes in these parameters under proposed operating scenarios, even using non-modeling techniques.

Susitna River Coalition et al. argue that the preliminary MODFLOW model for FA-128 does a poor job representing water levels in several wells, particularly those located away from the river, side channels, and sloughs. They recommend AEA: (1) not use a storage coefficient value for a confined aquifer to calibrate the model; (2) conduct additional aquifer testing at the Focus Areas to estimate hydraulic conductivity; and (3) use an integrated GW/SW model that can simulate small head differences in groundwater and surface water elevations and changes in groundwater temperature.

Comments on Requested Study Modifications

AEA states that the calibration of the FA-128 (Slough 8A) MODFLOW model is being refined, and new calibration statistics will be generated with a more detailed explanation provided in the USR. AEA proposes to use a more realistic aquifer storage coefficient as part of the FA-128 MODFLOW model refinement efforts. However, AEA opposes conducting additional aquifer testing because the slug tests it performed on 47 wells (12 wells in FA-104 (Whiskers Slough), 9 wells in FA-115 (Slough 6A), 20 wells in FA-128 (Slough 8A), and 6 wells in FA-138 (Gold Creek)) during the 2016 field season sufficiently measured values of hydraulic conductivity. In addition, AEA argues that this information coupled with the seepage data collected in the 1980s and as part of the current study (including new seepage meters that have been installed at key locations in Focus Area sloughs for the 2016 field season) will be sufficient to support model calibration efforts.

Further, AEA argues that no modifications to the study are needed because both the MODFLOW model and the Open-water Flow Routing Model can be adjusted to simulate short-term oscillations in stage. AEA further argues that sufficient temperature data for analysis exists and that it is developing methods to simulate groundwater heat transport, including the use of the mass transport code MT3DMS.[13] Other GW/SW temperature analysis will be based on a combination of the surface water temperature modeling coupled with empirical data collected at specific locations. Likewise, analysis of GW/SW DO relationships will be based on combined surface water-DO modeling coupled with empirical measurements of intergravel DO. AEA expressed confidence that the combined modeling and data analysis as planned and described in the ISR and SIR will be able to address potential project operational effects on water temperature and DO, and the resulting effects on fish and aquatic biota.

[13] MT3DMS is a modular three-dimensional multispecies transport model for simulation of advection, dispersion, and chemical reactions of contaminants in groundwater systems.

Discussion and Staff Recommendation

An integrated model is not necessary because groundwater flux to surface water is orders of magnitude lower than surface water influx at model boundaries, and accordingly surface water can be considered independent of groundwater. Therefore, using measured and/or modeled surface water as a boundary condition for the groundwater model is sufficient. While we agree that the development of AEA's model needs a more realistic storage coefficient as well as realistic values of hydraulic conductivity, it does not require the use of an integrated model. Furthermore, the models currently being used by AEA are fully capable of simulating small differences in head elevations. Finally, an integrated model will not be necessary to assess changes in water temperature if AEA is able to make the modifications to MODFLOW and conduct the assessments already required under the approved study plan. AEA's proposed methods will likely provide sufficient information to assess project effects on groundwater upwelling temperatures. Therefore, we do not recommend that an integrated GW/SW model be required at this time.

Basin-Scale Groundwater Flow Assessment

Requested Study Modifications

NMFS and FWS recommend that AEA perform a basin-scale groundwater flow assessment that analyzes the basin water budget and addresses recharge rates (and variations due to altitude or other factors throughout the basin); glaciers; permafrost; types, lithology, and transmissivity of aquifers and confining units; expected water table and/or potentiometric surface configurations; and discharge to tributaries. NMFS and FWS suggest that this type of analysis may best be conducted by using a sub-basin analysis, particularly those sub-basins above and below the proposed dam or contributing to the Focus Areas. They argue that this analysis will provide context and understanding of the processes involved in the "Broad-Scale Mapping." Further, they argue that this information is required as input to the groundwater model developed at FA-128. They also assert that the value of regional recharge used for the preliminary modeling effort differs by the regional value determined from the 1980s studies by an order of magnitude. Additionally, this analysis will inform how important groundwater is to the flow of the river on a season-by-season basis.

Comments on Requested Study Modifications

AEA states that this request is unnecessary because a basin-wide groundwater flow assessment is already incorporated into the series of study elements in the approved study plan for study 7.5. However, water budget estimates are limited to those areas with adequate data. The same level of analysis and understanding is not needed in all areas of the basin to evaluate potential project effects. AEA further suggests that data from study 4.5, study 5.5, study 6.6, the study 7.7, and study 8.5 will provide basin-scale information

that will contribute to the understanding of GW/SW interactions in the Susitna River Watershed.

Discussion and Staff Recommendation

The approved study plan follows ASTM 5979 in characterizing groundwater flow systems and requires that this characterization be sufficient for the problem being addressed. A basin-wide groundwater flow assessment is not needed because the majority of groundwater flow within the Susitna River Basin discharges to tributaries and not to groundwater flow systems adjacent to the river. Based on the information available at this time, we expect that conducting the approved study will be sufficient to develop any necessary license requirements (section 5.9(b)(4)). Therefore, we do not recommend requiring AEA to conduct a basin-wide groundwater flow assessment.

Short-Duration Hydrologic Event Data Collection and Modeling

Requested Study Modifications

NMFS and FWS recommend that AEA acquire additional field data and improve the current performance of GW/SW models to simulate short-duration (hourly) fluctuations in GW/SW interactions characteristic of future proposed project operations at each Focus Area. NMFS and FWS argue that "short duration temporal variations" can occur "in response to the various hydrologic events," such as precipitation, ice dams, river rise, or snowmelt. Analysis of these types of events is extremely challenging, and the averaging procedures used in the SIR study, such as 12-hour time steps, are not sufficiently detailed to capture the responses of the groundwater system, likely contributing to some of the anomalies that resulted from the studies. This is important because the project is also expected to produce significant short-duration temporal variations in flow (hourly and daily) that will not be well understood without additional work identifying the responses of the natural system to these short-duration events.

Comments on Requested Study Modifications

AEA states that the Open-water Flow Routing Model and groundwater flow models have the capability of simulating short-duration fluctuations, and the collected groundwater data will support the short time increment. These data include continuous (15-minute interval) groundwater and surface water level data and summer precipitation data at four Focus Areas (FA-104, FA-115, FA-128, and FA-138) and time-lapse camera images that provide information on the timing and conditions of spring snow melt. The amount of data is sufficient to determine the groundwater/surface water relationships of floodplain shallow aquifers and upwelling/downwelling within the Focus Areas. Importantly, since the field data have been collected on relatively short (15 minute) time scales, the assigned stress periods in the MODFLOW model can be adjusted to simulate effects on groundwater of short-duration fluctuations in surface flows. These types of

analyses are already embedded within the approved study plan and do not represent a study modification.

Discussion and Staff Recommendation

AEA's modeling approach and the data acquired thus far appear adequate to simulate short-duration project effects and are consistent with accepted practices for providing modeling results within the context of a hydroelectric licensing case (section 5.9(b)(6)). However, until the results of the predictive models are provided, it is premature to require AEA to collect additional data or refine its modeling.

Overbank, Breaching Flow, and Braidplain Side-Channel Flow Effects on Groundwater

Requested Study Modifications

NMFS and FWS recommend that AEA assess the current and future flows that would breach the head-of-slough barriers in the Middle River segment and flood in side channels of the braidplain (i.e., the flood plain of the channels) in the Lower River. NMFS and FWS argue that reduction of breaching flows would have an impact on groundwater levels near the affected sloughs, low bars, and islands.

NMFS and FWS argue that groundwater modeling studies as described by the modeling methodologies cited in the approved study plan all require that boundary conditions of a model reasonably simulate field conditions, including overtopping. This modification is warranted because the approved studies were not conducted as provided for in the approved study plan.

Comments on Requested Study Modifications

AEA states that one of the steps to complete study 8.5 includes measuring inlet elevations at major Middle River side channels and sloughs (both within and outside Focus Areas) to calculate breaching flows that affect habitat connectivity. Once defined, the current bed elevations associated with breaching will be compared with the bathymetric changes predicted for different project operational scenarios by the 1-D BEM at different locations throughout the Middle River segment. The 1-D BEM will be coupled with the more detailed SRH-2D sediment transport models developed for specific Focus Areas to enable more precise predictions of bed elevation changes affecting breaching flows within specific sloughs and side channels. These changes in breaching flows can then be linked with the respective groundwater models to determine potential effects on groundwater flux and ultimately how such changes may influence fish habitat via the 2-D fish habitat modeling. The bed elevation changes will be assessed at various intervals over the duration of the project and provide a means to evaluate potential changes in breaching flow conditions within the Focus Areas and more generally at other locations throughout the Middle River segment.

With respect to the Lower River, while AEA agrees with NMFS and FWS that there would be fewer and lower high-flow events in the Lower River with the project, these changes in peak and daily flows are not of the magnitude that would result in the dramatic changes in vegetation that NMFS and FWS present. AEA references the results of study 6.6 Technical Memorandum, dated September 26, 2014, in support of this conclusion and further asserts that this document demonstrates that the variability in 2-year peaks determined on a decadal basis indicate that project-induced changes are on the order of natural variability.

Discussion and Staff Recommendation

NMFS and FWS have identified a process important to overbank recharge (and therefore to riparian vegetation and upwelling/downwelling) that project operations could affect. However, the approved study plan already addresses NMFS's and FWS's requested study objective because it requires that the modeling be conducted in accordance with the ASTM standards and consistent with generally accepted scientific practice. At its most fundamental level, this means that models and/or methods must reasonably predict all processes important to evaluating project effects.

Because the study is ongoing and AEA has provided only limited study results to date, it is premature to conclude that AEA's proposed methods for evaluating groundwater effects caused by overbank, breaching, and braidplain side-channel flows are inadequate. We expect that preliminary modeling and integration results, when presented in the USR, will either confirm that the models and methods are sufficient to address these issues, or that additional data collection or alternative methods of analysis are needed to inform our analysis and develop license requirements (section 5.9(b)(4)). This is a reasonable and stepwise approach that is both consistent with the approved study plan and with accepted practices for completing and integrating aquatic and physical process models within the context of a hydroelectric licensing case (section 5.9(b)(6)). Thus we do not recommend modifying the study to include a special provision to evaluate overbank, breaching flow, or braidplain side-channel flow effects on groundwater.

Collection of Snow Survey Data at Focus Areas

Requested Study Modifications

NMFS and FWS request that AEA collect snow survey data at representative Focus Areas. NMFS and FWS argue that the current groundwater modeling efforts are hampered by a lack of key data for simulating direct groundwater recharge during the spring snowmelt period. They recommend that a snow survey be conducted during late March or early April before significant seasonal snowmelt occurs to establish appropriate transient groundwater recharge rates for the model. NMFS and FWS further argue that standard groundwater modeling methodologies as cited in the approved study plan are

clear that appropriate data (i.e., snow melt) should be used to establish groundwater recharge rates for transient model simulations where recharge is an important process.

Comments on Requested Study Modifications

AEA states that the approved study plan already requires it to estimate groundwater recharge during the spring snowmelt period, and collection of additional snow data is not necessary to meet this study objective. Specifically, AEA intends to apply regional spring snow survey data from the National Resources Conservation Service to estimate regional snow conditions for the field data collection periods. This information, along with analysis by the AEA-commissioned study 7.7 and field observations made during the instream flow and fish winter studies and riparian instream flow spring studies, will be used to estimate the potential influence of snowmelt on local GW/SW interactions. Additionally, the riparian instream flow team conducted snow depth measurements to specifically characterize snow water equivalents at FA-104 (Whiskers Slough) and FA-128 (Slough 8A) on April 4, 2014. Forty snow depth measurements were made at the FA-104 meteorological station and at an additional groundwater well station. Sixty-eight snow depth measurements were made at the FA-128 meteorological station. In addition, soil pits were dug in the spring to assess infiltration patterns from snowmelt and rainfall as part of study 8.6. AEA argues that these observations will help determine whether snowmelt infiltration to the groundwater table can alter groundwater levels.

AEA argues that it will use a combination of site data and the regional snow data from the National Resources Conservation Service to evaluate the relative importance of local recharge from rain and snowmelt flooding in Focus Areas.

Discussion and Staff Recommendation

The collection and acquisition of snow data described by AEA is consistent with the approved study plan. The use of regional snow data, as supplemented by project observations and measurements, is likely to be sufficient, although this will not be confirmed until AEA completes it model calibration and sensitivity analysis. Therefore, we do not recommend requiring AEA to collect additional snow survey data at this time.

Map-based Impact Assessment

Requested Study Modifications

NMFS and FWS recommend that AEA include an assessment of proposed project effects based on groundwater-influenced aquatic and floodplain habitat maps of the entire river corridor where impacts may occur rather than focusing only on preparing maps for groundwater-influenced habitats in the Middle River and upper portion of the Lower River. NMFS and FWS state that the "decision support system" needed for this project should be much more focused on preparing resource-based maps of the river corridor and

the creation of "impact zones" based on hypothetical but realistic scenarios of river and groundwater dynamics from data collected to date, aerial imagery, and field-based detailed mapping at a scale of approximately 1:6000 (1 inch = 500 feet) and models of river dynamics based on project operating scenarios. NMFS and FWS assert that AEA's approach to assessing groundwater influenced habitats requires complex modeling of large amounts of data and assumptions, with potentially questionable results. They suggest that reevaluation of these complex models in favor of simpler and less precise but more reliable overall assessments may be in order.

Comments on Requested Study Modifications

AEA states that this study is designed to collect information needed for comprehensive analyses of potential project impacts across several different study disciplines. AEA further argues that the NMFS and FWS's requested modification transcends the purpose of the primary study element, which is to provide broad-scale maps of groundwater influenced areas within the Middle River segment. Instead, the NMFS and FWS's requested modification relates to impact assessment and the decision support system, which are not part of the approved study plan for study 7.5, but rather part of study 8.5.

AEA notes that licensing participants have been directly involved in the selection of all of the detailed models that AEA is developing to assess impacts. Moreover, the majority of both oral and written comments proffered to date across all resource areas have been directed toward increasing rather than decreasing the level of study and model complexity. As detailed in AEA's response to the NMFS and FWS's request for a new model integration and decision support system study, model integration and the decision support system will be developed consistent with the approved study plan (RSP, section 8.5.4.8) to support the analysis of project effects and the identification of protection, mitigation, and enhancement measures as appropriate. AEA considers this modification request misaligned with the objectives of study 7.5 and premature.

Discussion and Staff Recommendation

The purpose of the mapping is to provide information on the extent and types of groundwater influence on aquatic and floodplain habitats that will be used in other studies. Because the study is ongoing and AEA has provided only limited study results to date, it is premature to determine the adequacy of AEA's mapping efforts and proposed methods for assessing project effects on groundwater flow. We expect that preliminary modeling and integration results, when presented in the USR, will either confirm that the models and methods are sufficient to address these issues or that additional data collection or alternative methods of analysis are needed to inform our analysis and develop license requirements (section 5.9(b)(4)).

Construction and Monitoring of Additional Wells at Focus Areas

Requested Study Modifications

NMFS and FWS recommend that AEA collect additional water table data in Focus Areas other than FA-128. They argue in all other Focus Areas too few wells were monitored for too short a time period to establish spatial and temporal distribution data for the subject Focus Areas. They assert that it is apparent from inspection of the water table maps for all of the Focus Areas except FA-128 that most of the groundwater data collection-stations are aligned along a single transect perpendicular to the river when standard groundwater modeling methodologies cited in the approved study plan require that transect models be aligned parallel to groundwater flow directions. This clustering of data makes for a poor water table map, which is key for three dimensional (3-D) or 2-D plan view groundwater flow modeling. As part of this proposed modification, NMFS and FWS argue that AEA should perform a data needs assessment to optimize data collection for periods of time that would be simulated by the models.

Comments on Requested Study Modifications

AEA states that the approved study plan does not specify the number of individual wells that must be installed at each of the Focus Areas. Rather, it states that they will be placed to best describe boundaries and to provide groundwater model input data or validation data sets (section 7.5.4.4). Example schematic layouts of well installations were provided that clearly illustrate the plans for installing some of the wells along transects oriented perpendicular to the river and no one objected to these plans. Comparison of those figures with the maps of the actual well locations confirms that the study plan includes these types of transect-based orientations for wells.

AEA further argues that the primary purpose of groundwater modeling for study 8.5 and study 8.6 is not to simulate the groundwater system for all aspects of groundwater hydrology but to develop an understanding of the interactions between potential stage (or flow) changes in the Susitna River from project operations and adjacent groundwater. The location of wells was geared to specific ecologically relevant locations (i.e., riparian areas and known fish spawning locations) to enable a better understanding of how project operations may influence these interactions and the corresponding riparian and fish and aquatic habitats.

With respect to 2-D transect modeling, AEA argues that the main driving mechanism for the GW/SW interactions is a pressure response (stage or water level change) between surface water features (i.e., main channel, side channel, sloughs, streams) and adjacent groundwater. The response does not propagate into the shallow groundwater system along flow lines, but rather depends on the nature of the stream and groundwater interface. The propagation is most similar to a 2-D plain (or transect) near straight stream sections or on the outside center of meander bends. The farther one moves away from the stream/groundwater (bank) interface into the groundwater system,

the assumption of 2-D GW/SW pressure effects likely becomes reduced. This is why groundwater wells were positioned along transects and near the bank to characterize the greatest levels of interactions (relative water-level changes) between groundwater and surface water.

Discussion and Staff Recommendation

The approved study plan does not specify the number of individual wells to be installed at each of the Focus Areas. However AEA has proceeded with groundwater data collection in a reasonable manner and consistent with the approved study methodology. Furthermore, while transect models may not accurately compute groundwater flux in many real-world transient situations, we agree with AEA that they can reasonably be used to assess pressure responses caused by river stage fluctuations in the direction normal to the river bank. Whether sufficient data and analysis will be available to produce a meaningful evaluation of project effects is presently unknown, but on the basis of what has so far been presented, we do not recommend requiring AEA to collect additional water table data.

Assessment of the Impacts of Geomorphic Channel Changes on Groundwater and Habitats

Requested Study Modifications

NMFS and FWS request that AEA include the effects of aggrading or degrading channels or other channel changes on groundwater and associated habitats to meet objective 6. They note that the effects of the project on the geomorphology of the river (aggrading or degrading channels or other channel changes) and consequent implications for groundwater and habitats need further development and should be included in the groundwater study. Current groundwater modeling uses only the current river channel configurations and stage for defining model boundaries. If channel down-grading or aggradation or other changes occur, these changes would affect groundwater. Evaluation of this effect is currently not part of the groundwater study, but it should be. Such changes in the river mean that the current modeled conditions would be considered anomalous compared to future conditions, thus justifying this modification.

Comments on Requested Study Modifications

AEA states that the geomorphology studies to date suggest that because so little sediment transport would occur under with-project conditions, the primary expression of width change (hence channel morphology change) would be through vegetation growth along channel and island banks. As part of the approved study plan, the existing groundwater data and analysis and modeling results can and will be used to draw some inferences about the projected geomorphic changes and how GW/SW relationships may be affected. The analysis and results specific to this will be provided in the USR.

Discussion and Staff Recommendation

AEA indicates that it intends to "draw some inferences about the projected geomorphic changes and how GW/SW relationships may be affected." If geomorphic changes result in appreciably changed surface water levels, adjacent groundwater levels may also be appreciably changed. As this analysis will be provided in the USR, we see reason to modify the study to include a provision for addressing channel aggradation and degradation on groundwater.

Measurement of Vertical Groundwater Gradients through Nested Observation Well Pairs

Requested Study Modifications

NMFS and FWS request that AEA install nested observation wells and measure vertical groundwater gradients to determine groundwater/surface water relationships of upwelling/downwelling. NMFS and FWS argue that the approved study requires the installation of nested monitoring wells, and AEA needs to justify why it did not include these wells to measure vertical groundwater gradients. NMFS and FWS argue that the lack of nested wells and measurement of vertical groundwater gradients hampers understanding of local and regional groundwater flow system relationships. The study plan also states that simulated hydraulic gradients will be compared to observed hydraulic gradients. Without collecting data on vertical hydraulic gradients, NMFS and FWS argue that it will not be possible to complete this analysis. NMFS and FWS recommend that field efforts occur to get the wells in place as soon as possible.

Comments on Requested Study Modifications

AEA states that although nested monitoring wells have not been installed, this will not affect its ability to determine GW/SW relationships of upwelling/downwelling in relation to spawning, incubation, and rearing habitats (particularly in the winter) within selected Focus Areas as part of study 8.5. AEA explains that it did not install the wells because the locations were too remote to allow access for large drill rigs capable of constructing them.

Nonetheless, it was able was able to construct wells to depths several feet below the seasonal high water table using portable auger drills and drive point methods. AEA argues that in lieu of nested wells, it will use a combination of data sets for estimating vertical gradients. The common occurrences of springs, wetlands, and small streams in upland areas, which provide a good idea of groundwater presence near the land surface, were not well understood when the study plan was written. These observations, coupled with the extensive temperature profile data and other empirical data, have proven useful in helping to understand the vertical components of the flow system. Most recently, AEA has installed and is collecting streambed seepage flow data (including direction and rate) at eight locations: two in FA-104 (Whiskers Slough), four in FA-128 (Slough 8A), and two in FA-138 (Gold Creek). AEA is confident that these combined data sets and other

hydrology measurements that were collected to assess groundwater contributions can be applied in understanding the vertical head gradients without needing to install additional wells.

AEA estimates the cost of adding 2 nested wells at 6 sites in each of 4 different Focus Areas for a total of 48 new wells would cost between $1,500,000 and $1,600,000. It would require a major change in well installation methods and field methods. Air rotary drilling methods and drill rig movement by use of Hughes scale helicopters would be required.

Discussion and Staff Recommendation

AEA's reliance on various lines of data to achieve a similar level of information appears to be a reasonable approach, especially given the high cost[14] and difficulty of collecting the additional data.

We note that the modeling of FA-128 indicates groundwater flow systems within the Susitna River system appear to be exceedingly complex such that AEA's alternative approach may not adequately characterize groundwater flow. This determination can be made upon review of the study results in the USR. Therefore, we recommend no changes to study at this time.

Study 7.6 – Ice Processes Study

Background

The purpose of the study is to describe ice processes in the Susitna River and develop a model that would allow AEA to assess the effect of project operations on downstream ice processes. The study objectives relevant to this determination include: (1) documenting the timing, progression, and physical processes of freeze-up and breakup during the winters of 2012–2014 between the Oshetna River confluence (river mile [RM] 233.4) and tidewater (RM 0); (2) determining the potential effect of various project operational scenarios on ice processes downstream of Watana Dam using modeling and analytical methods; (3) developing detailed models and characterizations of ice processes for selected Middle River Focus Areas; (4) assessing the potential for change to ice cover on the Lower River both for fish habitat studies and assessing the potential effects of the project on winter transportation access and recreation; and (5)

[14] AEA estimates the cost of implementing this modification to be between $1,500,000 and $1,600,000. This would require a major change in well installation methods and field methods. Air rotary drilling methods and drill rig movement by use of Hughes scale helicopters would be required. This cost assumes 6 sites in each of 4 different Focus Areas, 2 wells per site, for a total of 48 new wells.

reviewing and summarizing existing literature on large river ice processes relevant to the Susitna River, analytical methods used to assess the effects of projects on ice-covered rivers, and the known effects of existing hydropower project operations in cold climates.

Ice Interactions with Channel Bed and Banks and Formation of Open Water Leads

Requested Study Modifications

NMFS and FWS recommend that study objective 2 be modified to require that AEA describe how ice currently interacts with the channel bed and banks and how and why open leads form, and then, either using modeling or other methods, assess how these processes would change under the various operating scenarios.

In support, NMFS and FWS state that the River1D and River2D models, as currently described, fail to model many important ice processes. NMFS and FWS argue that the power of the river and the large slabs of ice are significant factors that shape the aquatic habitats along the river and at the slough heads. They argue that the current modeling effort does not recognize the "bulldozer-like" action of a slab of ice pushing through side channels or sloughs. They state that it is not only the hydraulics of open water flows that form or maintain these macro habitats as the HEC-RAS model suggests but also the action of moving ice.

NMFS and FWS also argue that the formation of open leads are prevalent features in the river and their presence is thought to correspond to areas of warm groundwater production, very high surface velocities, or a combination of the two. These factors would change under project operations. NMFS and FWS state that while the current study documents the presence of open leads and suggests that they are forming in similar locations to those that formed in the 1980s, the information does not describe how the leads form or how the modified flow regime would alter this process.

For these reasons, NMFS and FWS state that the current modeling approach neglects these important ice processes, and therefore, would not serve as an accurate predictive model. Accordingly, they state that the study was not conducted in accordance with the study plan.

Comments on Requested Study Modifications

AEA states that the selected models and methods have and will continue to meet the objectives of the approved study plan. AEA contends that ice interactions with channel bed and banks will be adequately evaluated using a combination of models (River1D and HEC-RAS with ice cover) and further describes the processes by which ice interacts with channel bed and banks.

AEA states that the evolution and persistence of ice open leads is a function of water velocity, air and water temperature, bathymetry, groundwater or seep flow, and turbulence. Because of complex 3-D flow and heat transfer characteristics, open lead

development or persistence is highly site specific and has not been modeled successfully to date. The site-specific models would require extensive field data acquisition for detailed bathymetry and velocity measurements in open water and ice conditions for calibration and verification. Field data measurements (if even possible under ice conditions) and the adaptations to existing 3-D models would cost several million dollars and take many years to accomplish.

AEA describes changes to processes affecting open leads that are expected with project flows. It further states that the comparison of the observations of ice open leads from the studies of the 1980s and from 2013–2014 confirm that the general number and locations of the ice open leads in the Susitna River have not changed, indicating that they are stable over a wide discharge range and long time period. The surface area of the open leads is also a small fraction of the total surface area of the Middle River that could contribute to the generation of frazil ice. The effect of the open leads on ice generation is minimal and determining any changes in ice cover response for post-project conditions would be within the margin error of the ice formation models.

Discussion and Staff Recommendation

The approved study plan already addresses NMFS's and FWS's requested study objectives. NMFS and FWS do not offer an alternative modeling approach, and we are not aware of any alternative models. Because the study is ongoing and AEA has provided only limited study results to date, concluding that AEA's proposed methods for evaluating ice processes are inadequate is premature. We expect that preliminary modeling and integration results, when presented in the USR, will either confirm that the models are sufficient or provide evidence that additional data collection or alternative methods of analysis are needed to inform our analysis and develop license requirements (section 5.9(b)(4)). This is a reasonable and stepwise approach that is both consistent with the approved study plan and with accepted practices for completing and integrating aquatic and physical process models within the context of a hydroelectric licensing case (section 5.9(b)(6)). Thus we do not recommend modifying the study objective 2.

Ice Jam Processes

Requested Study Modifications

NMFS and FWS recommend that study objective 3 be modified to require AEA to describe processes that cause ice jam initiation during three time periods (freeze-up, mid-winter, and breakup) and then, either using modeling or other methods, describe how that would change with the winter flows projected in the various operating scenarios. NMFS and FWS argue that juvenile salmon overwinter predominantly in side channels and sloughs.

NMFS and FWS note the current modeling effort ignores the important ice processes that happen in the four months between freeze up and breakup. They also state

that the ice jam study was not conducted as provided for in the study plan. They further find that the model neglects this important ice process, and therefore, is not an accurate predictive model.

Comments on Requested Study Modifications

AEA states that the River1D model reproduces the progression of the ice cover through the Middle River during freeze-up and to thermally grow or thin the intact ice cover over the mid-winter period and into the breakup period. The River1D progression of the ice cover during the freeze-up period accounts for freeze-up ice jamming that may be occurring with the assumption that the cover progresses from downstream to upstream as a single cover. Observations have shown that this assumption is generally true with the exception of two or three short ice covers that form but are overtaken by the advancing cover from downstream. The River1D model also provides the volume of ice that exists in the channel that is available to contribute to an ice jam. HEC-RAS will be used to develop water surface profiles of ice jamming locations based on the volume outputs of the River1D model. .

AEA agrees with the NMFS and FWS that ice jams could greatly alter the ice and water flow conditions in the side slough and back channel habitats of juvenile salmon. These changes will be addressed under objectives 2 and 3 of the approved study plan through coupled 1-D main channel and 2-D Focus Area modeling.

Discussion and Staff Recommendation

The approved study plan already addresses NMFS's and FWS's requested study objectives. NMFS and FWS do not offer an alternative modeling approach, and we are not aware of any alternative models. Because the study is ongoing and AEA has provided only limited study results to date, it is premature to determine the adequacy of AEA's proposed methods for evaluating ice processes. We expect that preliminary modeling and integration results, when presented in the USR, will either confirm that the models are sufficient or provide evidence that additional data collection or alternative methods of analysis are needed to inform our analysis and develop license requirements (section 5.9(b)(4)). Thus we do not recommend modifying study objective 3.

Study of Lower Reaches of Susitna River Tributaries

Requested Study Modifications

NMFS and FWS recommend that AEA expand the geographic extent of the current ice study to include the lowest 10 miles of the Chulitna, Talkeetna, and Yentna Rivers. NMFS and FWS state that the information presented in the ISR, appendix A, indicates that it is not consistent which river freezes or breaks up first.

Jan Konigsberg supports NMFS's and FWS's requests and recommend that other major salmon-producing tributaries in the Middle river be studied, including Indian River, Portage Creek, Deshka River, Willow Creek, Montana Creek, and Sheep Creek because these tributaries would not begin to freeze over until the Susitna River ice cover passes the tributary mouth and blocks tributary frazil-ice flow.

Comments on Requested Study Modifications

AEA states that preliminary model results show that the project would not affect water temperatures or the volume of frazil discharge at the Chulitna/Talkeetna confluence, and that the ice cover would reach the confluence at approximately the same time under project operations as they do under existing conditions. Further, the volume of frazil ice discharging from the Chulitna and Talkeetna Rivers would not change under post-project conditions. In addition, AEA states that results included in the USR will show no appreciable change to ice processes in the Lower River segment of the Susitna River; therefore, modeling the Yentna River is not necessary.

However, AEA states that river stage changes from increased project winter release rates would affect water levels and ice cover in the lower Chulitna and Talkeetna Rivers. Accordingly, AEA proposes to conduct additional HEC-RAS modeling (beyond the 2-D modeling of the confluence) of the three rivers confluence area (i.e., the lowest 3 miles of the Chulitna and Talkeetna Rivers) to assess stage-related project impacts on ice cover. AEA argues that 3 miles would be the maximum extent of the project influence, and modeling beyond that point is not necessary. AEA also argues that River1D modeling of ice processes within the Chulitna and Talkeetna Rivers upstream of their mouth is not necessary because these ice processes would not change from existing to post-project conditions, and HEC-RAS will be able to demonstrate the limited effects of the Susitna River ice conditions on the water levels in the Chulitna and Talkeetna Rivers at a reasonable cost.

AEA does not respond to Jan Konigsberg's letter. However, during the March 24, 2016, ISR meetings, AEA's consultant, Jon Zufelt, stated that some tributaries in the Middle River may experience some changes at their confluences, especially under open water conditions (i.e., possibly Portage Creek). Mr. Zufelt noted that many of the tributaries where this change in the mainstem Susitna River would occur are fairly steep, such that the effects on their ice processes from changes in the Susitna River are probably non-detectable.

Discussion and Staff Recommendation

We recommend AEA's proposal to conduct additional HEC-RAS ice cover modeling of the Chulitna and Talkeetna Rivers, because it is a reasonable approach for assessing project effects on those tributaries and it is necessary to inform our analysis and develop license requirements (section 5.9(b)(4)). Modeling efforts must include the

lowest 3 miles of the Chulitna and Talkeetna Rivers to assess stage-related project impacts on ice cover.

It is premature to require AEA to model the Deshka River and Willow, Montana, and Sheep Creeks, which discharge into the Lower River, until a calibrated and verified model has been developed and tested at simulating project effects at the confluence of the Susitna, Chulitna, and Talkeetna Rivers. Project effects for these rivers will be inferred from the results of the lower boundary of the River1D ice model. For these reasons, we conclude that AEA's proposed approach is consistent with accepted methods (section 5.9(b)(6)) and do not recommend modifying the study methods for further evaluation of Deshka River and Willow, Montana, and Sheep Creeks at this time.

With respect to Indian River and Portage Creek, which are located within the Middle River, the arguments put forth by Mr. Zufelt seem plausible. Given the steepness of the tributaries, which on the basis of project LiDAR are on the order of 8 to 10 percent, we expect that project effects would be minimal and limited to within a few hundred feet of the confluence. In addition, because winter flows are expected to be higher under project conditions and water temperatures would not be decreased by the project, we anticipate that ice at the mouth of the tributaries would be less likely to present a barrier to fish movement in those areas. Accordingly, we do not recommend modeling ice processes at the confluence of Indian River and Portage Creek beyond what is already required within the Susitna River in the approved study.

Modeling of Ice Processes Upstream of the Reservoir

Requested Study Modifications

NMFS and FWS recommend that AEA model ice processes from the bottom of the varial zone (approximately PRM 222) up to the Oshetna River confluence. NMFS and FWS argue that as the reservoir levels decline in the winter, they would leave large slabs of ice lying on the ground at the upstream end of the reservoir with a relatively small amount of water (100–2,000 cfs) working its way down a channel partially filled with the slabs, which would impede salmon and other fish migration and movement. NMFS and FWS assert that because the *Fish Distribution and Abundance in the Upper Susitna River Study* (9.5) and the *Salmon Escapement Study* (9.7 now indicate that salmon and resident fish may over winter in this reach, it is even more important that the ice processes be modeled in this zone.

NPS also recommends that AEA model the project reservoir so that it can assess how the 42-mile-long reservoir may interrupt wildlife migration and human passage. It states that ice formation and stability would be an important migration factor for many species of wildlife, especially caribou. NPS notes that developing wildlife, access, and recreation management protection, mitigation, and enhancement measures without knowing more about ice processes within the reservoir would be impossible.

Cathy Teich also requests that AEA modify the study to evaluate how ice cracks and ridges on a frozen lake would affect caribou. She argues that when the lake levels fall in the winter, cracks, ice shelving, and other ice conditions may form and affect caribou movement during the winter and spring.

Comments on Requested Study Modifications

AEA states that the conditions upstream of the proposed dam, including in the varial zone during the freeze-up, mid-winter, and breakup periods will be described in the license application using a combination of observations of existing conditions, theory, reservoir water quality modeling (study 5.6), and experience from other hydropower facilities with reservoirs in cold regions. AEA argues that by using these sources of information, it will be able to delineate areas within which no detectable change would occur, those areas that would be characterized by an ice-covered reservoir whose level is falling over the winter, and the varial zone that would begin the winter as a reservoir and end the winter as a river channel.

AEA further argues that modeling of the reservoir is not needed because at the "top" of the varial zone, the ice cover would form as a freeze-up accumulation of frazil and pans moving into the backwater of the reservoir, which would already be forming a smooth sheet ice cover. As the reservoir level drops, the floating surface ice would also drop and become stranded along the shore. AEA postulates that no large slabs of ice within the reservoir would form as NMFS and FWS contend. As the reaches of the varial zone drop to levels corresponding to the existing natural channel, the smooth reservoir ice cover would simply set down on the main channel bed, similar to what happens under mid-winter conditions when the rougher ice cover forms along the river sets down on the bed and depresses into the thalweg. AEA argues that upstream of the top of the varial zone, no detectable change in the river would occur as the reservoir continues to drop.

Discussion and Staff Recommendation

The study concerns raised by NMFS, FWS, and NPS are valid, but they do not offer an alternative modeling approach, and we are not aware of any models or other means that could be used to address how ice may react to fluctuating water levels at this time. While AEA's explanation of the processes that would occur under project operations seems plausible, it is not yet supported technically. Further, AEA's existing literature review provides no information to address this issue. Delaying the analysis that would support AEA's assertions until the license application would be inconsistent with the purposes of the Integrated Licensing Process (ILP), which is to resolve information needs pre-filing. Therefore, we recommend that AEA provide an analysis of how reservoir icing is expected to respond to the various operating scenarios in the USR. Based on that analysis, we will determine whether additional data collection or alternative methods of analysis are needed (section 5.9(b)(4)). This is a reasonable and stepwise approach that is both consistent with the approved study plan and with accepted

practices for completing and integrating aquatic and physical process models within the context of a hydroelectric licensing case (section 5.9(b)(6)).

Project Effects on Ice in Side Channels and Sloughs

Requested Study Modifications

NMFS and FWS recommend that AEA use either a new model or a completely new approach to assess project effects on ice characteristics and thickness in the side channels and sloughs to meet study objective 3. NMFS and FWS assert that side channels, sloughs, or tributary mouth habitats are critical to juvenile development at (1) times of open water, (2) water covered by ice, (3) water that is in large part frazil ice, (4) water interspersed with large overlapping slabs of ice that formed elsewhere, or (5) no water, and that the current distribution of these five winter environmental conditions needs to be understood. NMFS and FWS state that the study must predict whether the project would increase or diminish the availability of each condition during midwinter when juveniles are developing and early spring when fry are emerging from the gravel. NMFS and FWS further assert that River2D cannot model frazil ice or water interspersed with large overlapping slabs of ice, and the River1D model is not being used in the side channels, side sloughs, upland sloughs, and tributary mouths of the focus areas. NMFS and FWS do not recommend a study approach.

Comments on Requested Study Modifications

AEA states that the River1D model would be used to describe conditions in the main channel of the Middle River, and, based on the River1D results and other inputs, the River2D model would be used to describe conditions in selected Focus Area lateral habitats. The River1D model of the Middle River provides information on stage, discharge, water temperature, and ice thickness at each modeled cross section. These outputs from River1D are also used in conjunction with the aerial observations to determine the ice roughness, areas of smooth ice cover versus rough cover, flooding due to backwater effects of the developing main channel ice cover, open leads, and apparent velocities in the side channels and sloughs of the Focus Areas. AEA agrees with NMFS and FWS that River2D is not an ice formation or ice processes model per se but that the model incorporates discharge, detailed bathymetry, bed and ice roughness, plus user-defined ice thickness to calculate the 2-D depth (under ice) and velocity fields in the area of interest. The unsteady processes of ice cover initiation, growth, and jamming/decay over the entire winter in both the main channel and the side channels and sloughs can be simulated in a step-wise manner for the existing and post-project conditions. This approach, which is consistent with the approved study, will be sufficient to evaluate project effects in side channel and slough habitats.

Discussion and Staff Recommendation

NMFS and FWS do not offer an alternative modeling approach, and we are not aware of any alternative models that could be used to address this issue. Because the study is ongoing and AEA has provided only limited study results to date, it is premature to evaluate the adequacy of AEA's proposed methods for evaluating ice processes in side channels and sloughs. We expect that preliminary modeling and integration results, when presented in the USR, will either confirm that the models are sufficient or provide evidence that additional data collection or alternative methods of analysis are needed to inform our analysis and develop license requirements (section 5.9(b)(4)). Thus we do not recommend modifying the study objective 3.

Modeling of Lower Susitna River

Requested Study Modifications

NMFS and FWS recommend that AEA expand the geographic extent of the current study to include the Lower River. NMFS and FWS contend that under the load following scenario, the dam would release up to 12,000 cfs of 4°C water at the dam. Eighty miles below that, water would mix with less than 2,000 cfs from the Talkeetna and Chulitna Rivers. The amount and thickness of ice in the Lower River would change. Based on information from study 8.5, the stage in the lower river could vary daily by 2 feet mid-winter. This action would cause the hinge points on the edge of the suspended ice sheet to bend twice a day. They contend that contrary to AEA's assertion, the dam operator cannot set up a 300-meter-wide "bridged" ice sheet in December that would stay stationary for three months while the water flows underneath following the electric load. Such a bridge defies the laws of physics.

NMFS and FWS further assert that "This part of the approved study as mentioned in the study plan determination (April 1, 2013) was not conducted as provided for in the study plan."

Comments on Requested Study Modifications

AEA states that the intermediate load following dam release scenario indicates a range of dam releases of approximately 6,000 to 10,000 cfs during the winter period, and AEA's current thinking is that the water release temperature would be closer to 0.5 to 1.0°C, not the 4°C suggested by NMFS and FWS. These ranges of discharge fluctuation at the dam would experience some attenuation as they travel downstream, especially in ice-covered conditions but would also experience a general increase due to the addition of discharge from tributaries. Initial modeling of the 1984–1985 winter (average winter) with the River1D ice model shows that ice cover progression at these release temperatures would show limited ice above PRM 160, slightly delayed (5–10 days) progression between PRM 120 and PRM 160, and no detectable effect below the three rivers confluence (PRM 102.4). The Yentna and Chulitna Rivers are the primary ice

producers that contribute to the Lower River ice cover and would be unaffected by changes in the Susitna River discharge.

AEA further states that the ice cover would float on the surface of the water, whether that water is moving or stationary. At widths greater than approximately 30 feet, the ice cover would form cracks along the shore where it is grounded on the banks, and the floating cover would move up and down in response to changes in discharge and water elevation. The effects of existing changes in water elevation can be seen in mid-winter on the Susitna River where the cover becomes grounded in many places and floats on the thalweg at reduced elevations. As the discharge increases in the spring, the cover floats back up to fill the thalweg channel. Further, as reported in study 7.6, ISR, part C, appendix C, hydropower operators often manipulate the discharge to establish an ice cover under stable conditions and then increase the discharge once a stable ice cover is formed.

Discussion and Staff Recommendation

NMFS and FWS are essentially restating their concerns regarding modeling of ice processes in the Lower River, which we addressed in our April 1, 2013, study determination. They provide no new information to alter our initial April 1, 2013, determination. As explained there, AEA's approach to assess project effects on ice processes in the Lower River will be based on the magnitude of change seen at the downstream boundary of the River1D model and the estimated contributions of frazil ice to the Lower River from the Middle River from observations and modeling. These effects will be evaluated using simpler steady flow models (HEC-RAS with ice cover) for short sections of interest in the Lower River. The details of the final assessment will be established once the magnitude of effects at the upstream boundary of the Lower River is computed. While the concerns raised by the agencies are still valid, they cannot be fully addressed until after the Middle River model is developed and operating scenario effects are developed at the lower boundary. For these reasons, we conclude that AEA's proposed approach is consistent with accepted methods (section 5.9(b)(6)) and do not recommend modifying the study methods at this time.

Off-channel Habitat Areas Data Collection and Modeling

Requested Study Modifications

Susitna River Coalition et al. recommend that AEA modify the study to collect one full year of stage-discharge data in Focus Areas, complete aerial photography data collection to understand winter flows, ice breakup and the flooding of off-channel habitats, and to properly calibrate the model and address uncertainty. Susitna River Coalition et al. argue that AEA currently does not have sufficient data to understand the basic relationships among winter mainstem flows, ice breakup, and the flooding of side-channel and side-slough habitats. Susitna River Coalition et al. further indicate that the

study lacks appropriate aerial photographs and stage discharge data that would inform the River1D and River2D models of important relationships between the main channel and off-channel water exchange.

Comments on Requested Study Modifications

AEA states that the detailed bathymetric data that it collected and the 2-D Focus Area models being developed will allow it to develop stage discharge curves for the connecting side channels and sloughs based on the laws of physics. AEA asserts that examining a year's worth of measurements will only corroborate these relationships and not provide any new information. The bathymetry and stage discharge relationships also change with large floods, LWD accumulations, and ice jamming events. The important aspect is knowing how floods, LWD, and ice affect the physics of each connection such that future changes in flow (for which no data can be measured prior to dam operation) can be analyzed and thus properly modeled.

AEA further states that it is not possible to collect aerial photography or stage discharge measurements for conditions of post-project discharges in the winter because they have never occurred. AEA must rely on numerical models to "see" what is occurring beneath the ice cover during the winter in terms of depth and velocity because the cover itself blocks the view and access for measurements. The output of the models (River1D and River2D in the Focus Areas) combined with aerial observations of the appearance of the ice cover in the main and side channels provides valuable information concerning the conditions beneath the ice.

AEA maintains that it will collect the necessary data to validate and calibrate the models as provided in the approved study plan. The collected data will guide the modeling of both freeze-up and breakup using the River1D model, specific Focus Areas (e.g., FA-104, FA-113, FA-115, FA-128, and FA-138) using the River2D model, and general water elevation and ice jam thickness in the main channel during breakup using HEC-RAS with an ice cover. Coupled with measurements of ice thickness and water velocities, the River2D models would predict not only present conditions in the side channels and sloughs but also those expected during post-project operations. For the other Focus Areas (FA-141, FA-144, FA-151, FA-173, and FA-184), the level of modeling would be evaluated with consideration of all resources in the next year of study. Uncertainty of the various models and detailed results of the ice-covered modeling efforts will be provided in the USR.

Discussion and Staff Recommendation

Given the extensive bathymetry data that has been collected, AEA's approach of using hydrodynamic flow models to predict the distribution of flows between mainstem and off-channel areas would be more accurate than the approach recommended by Susitna River Coalition et al. Collection of stage-discharge data can provide present-condition open water flow estimates, but it will not provide information useful in

assessing project effects under ice cover or changed geometry conditions. We anticipate that the hydrodynamic models will be sufficient to evaluate water exchange between the main channel and off-channel habitats and develop license requirements (section 5.9(b)(4)). However, because model development is still ongoing, it is premature to require further data collection and study modifications. Therefore, we do not recommend collecting the stage-discharge or aerial photography data requested by Susitna River Coalition et al.

Additional Literature Search

Requested Study Modifications

NMFS and FWS recommend that AEA expand the literature search (objective 5) to include a discussion on ice processes that could affect fish habitat, effects of hydropower projects on the river ice regime, the impacts of other hydropower projects and non-hydropower projects on river ice regime, and a review of ice process modelling efforts on several hydropower projects. NMFS and FWS argue that a review of processes in lateral habitats of particular interest for fish habitat is lacking (e.g., back channels and sloughs that are characteristic to the Focus Areas). NMFS and FWS further assert that the review includes limited discussion on the evolution of open water leads and the various ice types (border ice, anchor ice, and frazil ice) in the back channels and on the interaction between ice processes in the main channel and ice processes in the side channels. The review summarizes some past literature but is not thorough enough to cover many important ice processes.

Comments on Requested Study Modifications

AEA argues that it has successfully completed the required literature review. AEA implies that additional literature review would not be helpful since it would be highly site specific. Similarly, AEA maintains that ice types and conditions in side and back channels are a function of conditions within the river, and modeling of the Focus Areas would consider those specific conditions.

Discussion and Staff Recommendation

The literature search presented in study 7.6, ISR, part C, appendix C, is reasonably thorough and conducted in accordance with the approved study plan. However, it focuses on ice processes below the dam. NMFS and FWS provide no information to support that any new information is available that would inform the development of ice process modeling. Further, the information they seek relates more to published studies on the effects of hydroelectric operations on the resources of interest to the agencies. While the use of existing literature to describe such effects is a well-established and accepted practice, it is typically done as part of an applicant's analysis in its license application and the Commission's environmental review of that information. We will

consider any such information provided by AEA or the agencies in any future environmental impact statement.

However, as discussed earlier, we are recommending that AEA provide an analysis of how project operations would affect ice processes within the reservoir in the USR.

Study 7.7 – Glacial Runoff Changes Study

Background

The purpose of the study is to analyze the potential effects of climate change on glacier wastage and retreat and the corresponding effects on streamflow entering the proposed reservoir, and evaluate the effects of glacial surges on sediment delivery to the reservoir. Study objectives include: (1) reviewing existing literature relevant to glacier retreat in southcentral Alaska and the upper Susitna Watershed and summarizing the current understanding of potential future changes in runoff associated with glacier wastage and retreat; and (2) analyzing the potential changes to sediment delivery from the upper Susitna Watershed into the reservoir from glacial surges.

The approved study plan only required AEA to complete the literature review and its proposed analysis of changes to sediment delivery from glacial surges. The completed literature review indicates that "glaciers, permafrost, and the hydrologic cycle are expected to change in response to anticipated future atmospheric warming by the end of this century, thus affecting water yields to the proposed Susitna-Watana hydroelectric reservoir." Potential changes to sediment delivery to the reservoir from glacial surges are documented in a November 2014 technical memorandum that concludes that the process would not appreciably affect the longevity of the reservoir.

AEA voluntarily carried out the other components of the study as it proposed in its RSP, including: (1) developing a hydrologic modeling framework that uses a glacier melt and runoff model and a Water Balance Simulation Model to predict changes in glacier wastage and retreat on runoff in the Susitna River Basin; and (2) simulating the inflow of water to the proposed reservoir to predict changes to available inflow using downscaled climate projections up to 2100. The study results indicate that by the end of the 21st century, annual streamflow in the Susitna River would decrease by about 7 percent, snowmelt is likely to occur earlier in the spring, and more precipitation would fall as rain. The study did not model the effects of project operations under future climate scenarios.

Basin-wide Climate Change Study

Requested Study Modifications

NMFS requests that AEA expand the AEA-commissioned study to include: an updated literature review summarizing information available since 2012, reviewing the

effects of climate change on ecosystems in the Susitna region and the species of interest to NMFS, and evaluating climate change within the entire Susitna River Basin. To accomplish this, NMFS recommends that AEA acquire and evaluate at least three downscaled climate projections for the Susitna River Basin; acquire and evaluate existing downscaled glacier and runoff projections for the Susitna River Basin that adequately sample a range of future conditions; acquire or develop projections for streamflow, water temperature, and quality below the proposed dam for use in assessing impacts of the project on species of interest under future climates; summarize the study in a Climate Change Technical Report; and coordinate study data and results with other studies and TWGs.

NMFS, citing various studies, argues that advancements in climate models and downscaled model output have been made since its 2012 study request and that its proposed study approach has become a generally accepted practice in the scientific community that has been used by water infrastructure and natural resource managers. Further, AEA's study is evidence that changing climate conditions would affect hydrology and water temperatures, which could affect the outcome or conclusions drawn from many other Commission-ordered pre-licensing studies upstream and downstream of the proposed dam. NMFS states that the concept of a stationary environmental baseline with fluctuations (high and low water years) around a relatively stationary mean (as previously used by the Commission and other regulators) is an outdated concept given the current level of scientific certainty of climate change and that a literature review alone is not adequate to assess the combined risks of climate change and project effects on anadromous fishes, marine mammals, and their habitats downstream of the proposed dam. NMFS recommends that AEA incorporate these results in the various modeling efforts of other studies (e.g., 6.6, 7.6, and 8.5).

NMFS estimates that it would cost AEA between $250,000 and $300,000 to augment the literature assessment of existing climate, water, and hydropower studies; acquire and analyze downscaled projections of climate and perform glacial and hydrologic modeling; develop projections of streamflow, water temperature, and quality below the project; and produce a technical report, archive available data, and coordinate with other studies. NMFS explains the main uncertainties in its cost projections include suitability and availability of new dynamically downscale projections and whether existing or new modeling is needed to project streamflow and water temperature and water quality changes.

Natural Resources Defense Council, The Nature Conservancy, and Rebecca Long essentially make the same study modification request as NMFS and supply the same or similar arguments.

Susitna River Coalition et al. recommend AEA include climate change projections for the life of the proposed project. Similar to the recommendation from NMFS, they suggest that a range of emissions scenarios and global circulation model output should be included in evaluations and simulations of project impacts. Susitna River Coalition et al.

argue that it is difficult to imagine how the current 1-D hydraulic models could be used to simulate changes to the existing, natural hydrologic flow conditions as a result of climate change because all of the boundary flows depend on historical mainstem and tributary boundary inflows. For example, the loss of glaciers would strongly influence catchment hydrology, to the point that current estimates of tributary inflows based on catchment size would not be valid. Simulating flow conditions with a fully integrated flow model, with an appropriate snowmelt model component (i.e., MIKESHE), would permit evaluation of such conditions, driven by expected external climate changes.

Comments on Requested Study Modifications

AEA states that it concurs with commenters on the appropriateness of a climate change study for the project and, in fact, that was the basis for conducting the AEA-commissioned study. Nevertheless, AEA asserts that predicting specific streamflows, water temperature, and water quality changes; comparing these changes in future baselines to operational scenarios; modeling effects on environmental resources; and then developing protection, mitigation, and enhancement measures would yield speculative results with enormous uncertainty. Moreover, AEA states that NMFS has well underestimated the costs to model the entire basin and run the various scenarios. AEA estimates that modeling of climate change for three General Circulation Models would be on the order of $1.5 million just to run the models and that is irrespective of developing the basin model for climate change. After adding temperature and expanding the study to include the entire basin, the cost would be about $5 million.

AEA points out, the results of its analysis allows interested parties to look at the directionality of climate change and assess the influence of climate change on species and their habitat. AEA argues that because the results of the study look at the most likely climate change scenario (other models would only accelerate the rate of change), it would be easy to consider trends for even warmer temperatures and/or greater precipitation. The range of meteorology (warm year) and hydrology (low flow) that AEA is evaluating should be sufficient to develop protection measures and illustrate project effects against a changing climate.

Accordingly, AEA suggests that its completed study, coupled with the sensitivity analysis that it intends to conduct as part of the currently approved study plan, would provide sufficient information to assess impacts on environmental resources downstream of Watana Dam and trends associated with climate change.

Discussion and Staff Recommendation

NMFS, Natural Resources Defense Council, and The Nature Conservancy are essentially restating their original request for a climate change study of the entire basin. The approved study plan only requires AEA to conduct a literature review because of the uncertainty of the predictive ability of existing models, high cost of modeling, and because the effects of the project on environmental resources of the project area can be

effectively studied and evaluated using conventional hydrologic studies, monitoring techniques, and predictive models (section 5.9(b)(6)). Nothing in the various comments or study requests causes us to reconsider those findings.

As AEA points out, NMFS's comments contradict its need for further study when it stated: "NMFS does not need to know with precision the magnitude of change over the relevant time period if the best available information allows NMFS to reasonably project the directionality of climate change and overall effects to species and their habitats." This directionality is already known and can be considered in the context of the results of other required studies.

AEA's literature review was comprehensive at the time it was completed. As AEA points out, "as with any developing science, literature will continue to be published on glacial and runoff conditions and ecosystem effects related to climate change." AEA intends to include appropriate literature in its reports and license application as they are developed and filed with the Commission. Therefore, we do not recommend modifying the study.

Study 8.5 – Fish and Aquatics Instream Flow

Background

The goal of the study is to provide quantitative indices of existing aquatic habitats to assess the effects of alternative project operational scenarios. This requires integrating a wide range of interrelated studies, including hydrologic, physical, and chemical processes, and aquatic resources and habitat that provide inputs to an overall project effects analysis. Study objectives include: (1) using the results of study 9.9 to understand the frequency and distribution of habitats to inform site selection for a variety of studies and provide the basic framework for extrapolation; (2) selecting study areas and sampling procedures via a collaborative process involving this study and numerous other studies (e.g., riparian instream flow, groundwater, geomorphology, water quality, and fish distribution) to collect data and information to characterize, quantify, and model mainstem and off-channel habitat types at different scales; (3) developing a mainstem open-water flow routing model that estimates water surface elevations and average water velocity along modeled transects on an hourly basis under alternative operational scenarios;[15] (4) developing site-specific habitat suitability criteria (HSC) and habitat suitability indices (HSI) for various species and life stages of fish selected in consultation with the TWG; (5) developing integrated aquatic habitat models to produce a time series of data for a variety of metrics under existing conditions and alternative operational

[15] The open-water flow routing model results will provide input to other models proposed to evaluate the effects on specific habitat elements and aquatic resources.

scenarios;[16] (6) evaluating existing conditions and alternative 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) coordinating instream flow modeling and evaluation procedures with other study efforts (e.g., riparian, geomorphology, groundwater, water quality, fish passage barriers, and ice processes); and (8) developing a decision support system to conduct a variety of post-processing comparative analyses derived from the output metrics estimated under aquatic habitat models. These output metrics include, but are not limited to: seasonal juvenile and adult fish rearing, habitat connectivity, spawning and egg incubation, juvenile fish stranding and trapping, ramping rates, and distribution and abundance of benthic macroinvertebrates.

To date, AEA has stratified the Middle River segment into eight geomorphic reaches and the Lower River segment into six geomorphic reaches, and has defined selected study areas (i.e., Focus Areas) in the Middle River and study sites in the Lower River. AEA has collected field data, including mainstem Susitna and tributary hydrology data, bathymetry and topographic data, HSC/HSI fish habitat data during both the winter and open-water periods, and substrate and cover data.

AEA developed Version 2.0 of the open water flow routing model and used it to inform various riverine resource studies and guide field activities. Bathymetric, Acoustic Doppler Current Profiler and substrate/cover characterization surveys have been performed for seven of the ten Focus Areas. AEA collected fish habitat availability and use data at seven of the ten Focus Areas in addition to locations outside Focus Areas to support developing HSC/HSI for priority fish species and life stages. Winter studies were performed within three Middle River Focus Areas. Physical and hydrologic surveys were conducted in the Lower River to support 1-D modeling.

Ongoing field data collection efforts include: bathymetry and topographic data for three of the ten Focus Areas; habitat availability and use data to support developing HSC/HSI; supplementary topographic data; water surface, flow, and water temperature data; and winter studies, including water quality and HSC/HSI sampling.

Ongoing analyses include: priority species life stage periodicities; breaching flows; indicators of hydrologic alteration and environmental flow components; 1-D and 2-D flow-habitat analyses; and study integration and a decision support system.

[16] These metrics may include, but are not limited to: water surface elevation at selected river locations, water velocity within study area subdivisions (cells or transects) over a range of flows during seasonal conditions, length of edge habitats in main channel and off-channel habitats, habitat area associated with off-channel habitats, clear water area zones, effective spawning and incubation habitats, varial zone area, frequency and duration of exposure/inundation of the varial zone at selected river locations, and HCI.

Ongoing model development includes: reservoir operations model, 2-D hydraulic models in Middle River Focus Areas (developed under study 6.6) and 1-D hydraulic models for Lower River study sites, visual basic models used in developing HSC/HSI, effective spawning/incubation and salmon rearing models, and varial zone models.

Additional Study Sites

Requested Study Modifications

NMFS and FWS recommend expanding the instream flow study sites in the Middle River and Lower River. NMFS and FWS state that the location and number of study sites do not adequately represent all habitat variables within the available macrohabitats in these river segments. For the Lower River, NMFS and FWS recommend that AEA conduct additional surveys to locate salmon spawning and rearing sites and then develop representative Focus Areas for intensive study and modeling of these sites similar to the process used for the Middle River.

FWS also recommends that AEA work with the TWG to identify specific habitats for study within tributaries to the Susitna River (e.g., Talkeetna and Chulitna Rivers) that are "critical" for adult and juvenile fish throughout the entire Susitna River Basin (and not just the Middle or Lower River).

Comments on Requested Study Modifications

AEA states that the study approaches used in the Middle River and Lower River segments are different because the size and complexity of the river increases, and project effects would attenuate in a downstream direction away from the dam site. AEA indicates that it selected the Lower River 1-D study sites to represent main channel, off-channel, and tributary mouth habitat types. AEA suggests that tributary mouth habitats were selected in areas known to be important for salmon spawning based on the 1980s data, and utilization of these habitats by adults during holding and spawning were confirmed by the results of study 9.7.

AEA also states that FWS had ample opportunity during study plan development to recommend including additional study sites in "critical" habitats in Susitna River tributaries.

Discussion and Staff Recommendation

FWS and NMFS do not provide any specific information with respect to the level of effort and cost of their recommended additional study sites or how many additional study sites in the Middle or Lower River segments would be necessary to, in their view, meet the study objectives. Without additional detail, it is not possible to ascertain specifically what FWS and NMFS are requesting, the additional information that would

result, or how the additional information would better inform the assessment of project effects.

Commission staff approved the Focus Area sampling approach proposed in the Middle River because it was a reasonable approach for capturing the range of macro and mesohabitats present within the Middle River segment. The approach uses ten Focus Areas selected within six of the eight Middle River geomorphic reaches, excluding reaches MR-3 and MR-4 because of safety considerations related to Devils Canyon. The 1-D open-water flow routing model developed for the Middle River Segment (excluding Devil's Canyon) will be used to inform 1-D and 2-D modeling within Focus Areas. Intensive studies within Focus Areas will be used to parameterize site-specific models and characterize habitat conditions. The hierarchical channel classification system provides a reasonable framework for selecting sampling locations and extrapolating results for Focus Areas to areas outside Focus Areas elsewhere in the Middle River segment. At this point, AEA's data collection and modeling within Middle River Focus Areas is ongoing, but we anticipate that AEA's studies in the Middle River segment are on track for providing sufficient information to evaluate project effects (section 5.9(b)(4)) across the full range of macrohabitats in the Middle River. Therefore, we do not recommend requiring AEA to expand Middle River study sites at this time.

With regard to the lower river study sites, AEA's approach for instream flow modeling includes selecting 1-D study sites in the upper portion of the Lower River to evaluate project effects on fish habitat throughout the Lower River. At this point, the data collection and modeling are ongoing; therefore, it is unclear how much and to what extent project effects on fish habitat would extend into the Lower River segment, and it would be premature to require AEA to expand the Lower River sampling at this time. However, if the modeling results presented in the USR indicate that more information is needed to inform our analysis of project effects on fish habitat in the Lower River (section 5.9(b)(4)), then we could require additional study sites and/or expanded sampling in the Lower River at that time. Therefore, we do not recommend expanding the Lower River study sites at this time.

However, to improve our understanding of the representativeness of the study sites to all habitat types in the Middle and Lower River segments, we recommend that AEA include in the USR a complete description of the habitats sampled within Middle River and Lower River study sites and the availability of those habitats within each geomorphic reach.

We do not recommend requiring AEA to develop study sites in tributary habitats that are "critical" for adult and juvenile fish as recommended by FWS. With the exception of a short segment of the tributaries at their confluence with the Susitna River, the project would not affect any habitats within the tributaries. Therefore, any information obtained from such study sites would not be used for our analysis or to develop license requirements (section 5.9(b)(5)).

Modeling of Operational Scenarios

Requested Study Modifications

NMFS and The Nature Conservancy recommend that AEA evaluate the project's effects on habitat availability for each operational scenario evaluated under various PDO scenarios.

FWS also recommends evaluating changes to habitat classifications under different project operational scenarios.

Comments on Requested Study Modifications

AEA states that the PDO analysis revealed no identifiable influence of warm or cool PDO periods on wet, average, and dry conditions, except during the winter, when higher winter flows were associated with warm PDO and lower winter flows were associated with cool PDO. AEA indicates that it did not include additional years to reflect warm and cold PDO periods because the preliminary results did not support making this distinction.

AEA states that habitat typing was conducted at reference flows that encompass the majority of post-project operational flows that were observable under pre-project conditions. AEA suggests that selecting a reference flow that represents both baseline and post-project flows minimizes the influence of main channel flow changes on habitat characterizations. AEA indicates that incorporating flow-related changes in habitat characterizations would add increased complexity to an already complex riverine modeling effort without providing any benefit to the decision-making process.

Discussion and Staff Recommendation

The approved study plan (see section 8.5.4.4.1.2) requires AEA to select five representative years for analysis of wet, average, and dry conditions, and warm and cold PDO phases so that project effects for various project operating scenarios could be evaluated under a range of climatic and hydrologic conditions. The results of AEA's analysis suggest that warm and cold PDO cycles would not have a detectable geomorphic influence based on a comparison of annual hydrographs, flow duration curves, and statistical comparisons using the Wilcoxon Rank Sum test. Thus, we anticipate that the representative years selected by AEA will adequately cover the inter-annual variability of hydrologic and climatic conditions regardless of the PDO cycle. Therefore, the representative years selected by AEA are sufficient to inform our analysis (section 5.9(b)(4)) and we do not recommend requiring AEA to attempt to assess projects effects on habitat availability under warm and cold PDO scenarios.

AEA classified habitats under study 9.9 during low-to-moderate flow conditions using aerial imagery, videography, and ground-based surveys. Aquatic habitat mapping under these flow conditions was intended to provide an opportunity to observe underlying

bedforms and an understanding of their influence on habitat and flow characteristics. 1-D and 2-D hydraulic modeling performed for this study will be used to describe how changes in flow affect depth and velocity within study sites and to quantify and estimate the associated change in habitat area over a wide range of flows. Reclassifying habitat at new flow levels under potential project operational scenarios would substantially complicate this analysis and is not customary in hydroelectric licensing studies (section 5.9(b)(6)). In addition, some flow conditions that would occur under various project operational scenarios would likely not occur under existing conditions (e.g., higher winter flows); therefore, it is unclear how AEA could complete the recommended study modification. For these reasons, we do not recommend requiring AEA to evaluate changes to habitat classifications under differing project operational scenarios.

Study Sequence and Duration

Requested Study Modifications

FWS recommends that AEA complete a minimum of two consecutive years of data collection for all physical and biological studies within each Focus Area. FWS contends that two consecutive years of data collection for each study is necessary to populate and test predictive capabilities of aquatic habitat models for spawning and rearing fish.

FWS also recommends that AEA segregate the study results for each of the two years of data collected to date, and that the Commission should only consider the first year's data in the study plan determination. FWS states that it did not have a chance to review and comment on the 2013 data; FWS believes the data were not collected according to the approved study plan and contends that the Commission should complete its determination on the first year's data collection before completing the determination on both years' study results.

Comments on Requested Study Modifications

AEA states that it recognizes the need for adequate data to populate and test predictive capabilities of aquatic habitat models. However, AEA contends that development of aquatic habitat models is not dependent on two consecutive years of data collection but rather is dependent on obtaining sufficient channel, hydraulic, and biological data to characterize existing conditions and support development of riverine process and fish habitat models to evaluate proposed project operations. AEA also indicates that all data collected in 2013 and 2014 were collected in accordance with the approved study plan, including quality assurance/quality control procedures.

Discussion and Staff Recommendation

The approved study plan does not require AEA to collect all interdisciplinary study data in Focus Areas in two consecutive years, and consecutive years of data

collection are not a prerequisite to developing accurate aquatic habitat models (section 5.9(b)(6)). Instead, accurate model development is predicated on collecting a sufficient amount of data to adequately parameterize, calibrate, and validate each model to an acceptable level of resolution and certainty or statistical power (i.e., predictive ability). At this point, data collection and model development for this study are ongoing; however, there is no reason to conclude at this time that the data AEA already collected coupled with the additional data it proposes to collect during the next study season would be insufficient to meet the study objectives (section 5.9(b)(1)) and inform staff's analysis (section 5.9(b)(4)). Therefore, we do not recommend requiring AEA to complete two additional consecutive years of data collection for all study efforts within Focus Areas.

Additionally, AEA can collect any information that it believes would add pertinent information to the project record, and section 5.9(b)(4) of the Commission's regulations requires that we consider any such information when determining the need for additional study. Therefore, we are considering all available information in the project record in this determination, and we see no reason to require AEA to segregate study results by the year they were collected or to only consider the first year's study results in this determination.

Data Collection for Model Development

Requested Study Modifications

FWS recommends that AEA modify its data collection where appropriate to meet the Commission's requirement that modeling results must be able to evaluate pre- and post-project conditions to fully assess project impacts.

Comments on Requested Study Modifications

No entity commented on this request.

Discussion and Staff Recommendation

Based on the study results presented to date and AEA's plans to complete the study, we anticipate that AEA's study methods will be sufficient to develop the models necessary for our analysis of the existing condition as well as project effects under multiple potential operational scenarios, ranging from run-of-river operation to AEA's proposed maximum load following scenario (section 5.9(b)(4)). Therefore, we do not recommend requiring AEA to modify the data collection in the approved study plan.

Modeling

Requested Study Modifications

FWS recommends that the instream flow study be modified to address winter fish-habitat preference for future conditions that do not currently exist and are therefore unobservable (e.g., new mid-winter ice-free reaches under project operation).

FWS recommends modifying the instream flow study plan to include a description of how weighted usable area (WUA) will be calculated and modeled.

Comments on Requested Study Modifications

AEA states that HSC/HSI data have been collected in winter under ice and open-water habitats and suggests that fish habitat modeling will be applicable to both open-water and ice-cover under existing conditions and alternate operating scenarios. AEA acknowledges the importance of modeling ice breakup and ice dams and their effects on fish habitat.

AEA states that it recognizes the need for adequate data to populate and test predictive capabilities of aquatic habitat models for spawning and rearing fish. AEA indicates that much of the field data collection needed to develop physical and hydraulic models has been completed.

Discussion and Staff Recommendation

The approved study plan already requires AEA to develop HSC and model aquatic habitat availability for target species and life stages during both open-water and ice-cover conditions (see RSP sections 8.5.4.5–8.5.4.7), and FWS does not provide any specific information with respect to how the study should be modified to better address winter fish-habitat preferences under proposed project operation. At this point, we anticipate that AEA's proposed modeling will be sufficient to inform our analysis and develop license requirements (section 5.9(b)(4)). Therefore, we do not recommend requiring AEA to modify the study plan to address winter fish-habitat preferences.

The approved study plan, ISR, and supporting documents describe the general approach AEA plans to implement for study 8.5, which includes a description of how HSC/HSI models will be developed and WUA calculated (see RSP section 8.5.4.5). WUA is a numerical calculation of habitat availability derived from modeling life-stage specific HSC for hydraulic conditions over a range of flows. HSC curves are developed for habitat variables such as depth, velocity, substrate, and/or cover and are based on habitat availability and use data. These curves are then 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 WUA. AEA's approach for developing species and life-stage-specific flow-habitat relationships, including modeling and calculating WUA as described above, is adequate and consistent with accepted

practices (section 5.9(b)(6)). Therefore, we do not recommend requiring AEA to modify the study plan to include a description of how WUA will be calculated and modeled.

Model Extrapolation

Requested Study Modifications

NMFS, FWS, Susitna River Coalition et al., and The Nature Conservancy recommend that AEA develop and describe methods for extrapolating Focus Area model results to the entire river system. To provide NMFS and FWS with assurance that AEA can successfully extrapolate its Focus Area modeling results to other areas that were not intensively studied, NMFS and FWS recommend that AEA only provide modeling results in the USR for several operational scenarios within a "pilot area" consisting of one or two Focus Areas, rather than providing modeling results for all Focus Areas as AEA proposes.

Comments on Requested Study Modifications

AEA states that spatial extrapolation was discussed during the April 15-17, 2014, Riverine Modeling Technical Team Proof of Concept Meeting, and it presented options for extrapolation by linear distance, macrohabitat linear distance, macrohabitat area, and macrohabitat weighted by fish use. However, AEA states that it has not finalized its methods for extrapolation because model development and integration are ongoing and will continue during the next study period. AEA contends that the approved study plan already requires it to describe how it will extrapolate areas of intensive study to the entire river system.

Discussion and Staff Recommendation

AEA's proposal to provide preliminary modeling results for the entire river basin in the USR is an accepted practice (section 5.9(b)(6)) for presenting study results, and all stakeholders will have the opportunity to review the results and assess AEA's chosen methods for extrapolation at that time. Therefore, we do not recommend requiring AEA to only include modeling results and methods for extrapolation for one "pilot area" and to withhold the remaining information and analyses for the rest of the river basin until an unspecified later date after the filing the USR.

Habitat Values

Requested Study Modifications

NMFS and FWS recommend that AEA produce tallies of different macro, meso, and micro habitats weighted by "value" to various organisms for each proposed alternative as are typically generated in aquatic habitat modeling efforts. NMFS and

FWS state that the emphasis should be on how the various modeling efforts can produce side-by-side comparisons of project alternatives (including a no-project alternative).

Comments on Requested Study Modifications

AEA states that the intent of the ISR is to describe AEA's overall progress towards implementing the approved study plan, and that the RSP does not require that study results or model files be available at the current ISR stage. AEA indicates that it acknowledges the overall complexity of the analyses and has continued to make progress since the April 15-17, 2014, Riverine Modeling Proof of Concept Technical Team meeting in the integration of the different resource model outputs as outlined in the analytical framework described in study plan section 8.5 (RSP section 8.5.4.1).

AEA states that study 8.5 will result in the collection of data and development of different types of habitat-flow relationships from spatially distinct locations within each of the Focus Areas that contain a variety of habitat types. Types of relationships will include, but not be limited to, those founded on PHABSIM that depict WUA or habitat versus flow by species and life stage; effective habitat versus discharge relationships that define how spawning and incubation areas respond to flow changes; and groundwater-surface water flow relationships relative to upwelling and spawning habitats.

Discussion and Staff Recommendation

It is unclear what exactly NMFS and FWS are requesting with respect to their recommended habitat tallies, and we are not aware of any instances where it was necessary for a potential license applicant to produce such tallies to evaluate the effects of a hydroelectric project (section 5.9(b)(6)). The approved study plan already requires AEA to develop a decision support system in collaboration with the TWG to support decision making and evaluate project effects on physical habitat and biological resources under various operational alternatives. Although data collection, modeling, and decision support system development are incomplete and ongoing, at this time, we expect that the modeling results coupled with the decision support system will be adequate to inform our analysis and to develop license requirements (section 5.9(b)(4)). We therefore do not recommend requiring AEA to produce tallies of different macro, meso, and micro habitats weighted by "value" to various organisms.

Additional Habitat Suitability Criteria Development

Requested Study Modifications

NMFS and FWS recommend expanding the instream flow study to include developing HSC for both open-water and ice-cover conditions for each target species and life stage at each unique macrohabitat type identified within the hierarchical channel classification system. For the winter ice-cover period, they recommend increasing the number of study years and frequency of sampling to include monthly sampling of

macrohabitats for all target species and life stages at a minimum of six replicate tributary mouths, main channel or side channel backwaters, side sloughs, and upland slough habitats.

NMFS and FWS also recommend developing additional HSC/HSI curves for fish behavioral response to short-term flow fluctuations (i.e., ramping) under the proposed maximum and intermediate load-following scenarios.

Comments on Requested Study Modifications

AEA states that the distribution and number of HSC study areas will be based on a stratified random sampling approach that is not only based on the hierarchical channel classification system, but also on several other attributes, including levels based on river segment, geomorphic reach, mainstem habitat composition, relative fish use, number of instream flow Focus Areas, and mesohabitat composition and site-specific attributes, including the presence of groundwater upwelling, water clarity (turbid vs. clear water areas), and safety concerns. The study plan also indicates that a stratified random sampling scheme will be used to select study areas to cover the range of habitat types.

AEA states that development of HSC to reflect fish habitat selection in response to short-term flow fluctuations (i.e., ramping) would require that flow levels in the Susitna River be manipulated to simulate ramping conditions; however, because the river is unregulated, flow manipulation and HSC data collection under ramping conditions are not possible.

Discussion and Staff Recommendation

Preliminary study results in the ISR and other study reports indicate that AEA is using its hierarchical channel classification system to select HSC/HSI study sites as specified in the approved study plan. The approved study plan does not, however, require AEA to generate separate HSC/HSI for each target species and life stages at each macrohabitat type during both open-water and ice-cover periods. This would require an extraordinary amount of additional sampling effort and cost (section 5.9(b)(7)) to achieve sufficient sample sizes (i.e., number of observations) to determine whether meaningful differences in habitat use are evident between macrohabitats (for each geomorphic reach and hydrologic segment). Such an approach would also substantially increase the complexity of the habitat analyses beyond what is already proposed in the approved study plan. In addition, this recommended level of sampling and HSC development are not customary for hydroelectric licensing instream flow studies (section 5.9(b)(6)). Therefore, we do not recommend requiring AEA to develop separate HSC/HSI for target species and life stages for each macrohabitat during both open-water and ice-cover conditions within the hierarchical river stratification framework.

With regard to the need for additional HSC sampling during the winter, AEA's winter sampling efforts completed to date include winter pilot studies during 2012–2013

and expanded winter surveys during 2013–2014. Sampling during both winters included observations of site-specific habitat utilization data for juvenile and adult fish species in support of HSC/HSI development. Additional winter surveys to support HSC/HSI development are planned for the next year of study. At this point, HSC sampling during the winter is incomplete and ongoing. We will review AEA's winter sampling results in the USR, including development of winter-specific HSC/HSI, to determine if they are sufficient to inform our analysis of project effects on aquatic habitat during the winter ice-cover period (section 5.9(b)(4)). Therefore, we do not recommend at this time requiring AEA to conduct additional monthly sampling during the winter at a minimum of six replicate tributary mouths, main channel or side channel backwaters, side sloughs, and upland slough habitats.

With regard to evaluating the behavioral response of fish to project-induced flow fluctuations, such an evaluation would be difficult if not impossible under existing conditions because of the lack of controlled flow releases. In addition, behavioral studies such as those suggested by NMFS and FWS are not customary for instream flow studies (section 5.9(b)(6)); rather, an evaluation of stranding and trapping risk is typically used and is already a requirement of the approved study plan (see section 8.5.4.5.1.2.2.). Therefore, we do not recommend requiring AEA to develop additional HSC/HSI curves for fish behavioral response to short-term flow fluctuations.

Evaluating Vertical Hydraulic Gradient as an Habitat Suitability Criteria Microhabitat Variable

Requested Study Modifications

NMFS and FWS recommend that AEA modify the HSC study experimental design by comparing the dependence of fish habitat selection on vertical hydraulic gradient (VHG). NMFS and FWS contend that this can only be accomplished by surveying habitats with a different VHG. FWS recommends that AEA measure groundwater upwelling and downwelling in Focus Areas for HSC/HSI to assess the importance of relative gradients. FWS states that small differences in gradient are relevant to fish at the micro-scale. NMFS and FWS contend that the methods used by AEA to assess VHG and develop HSC are insufficient to adequately characterize important habitat relationships between upwelling/downwelling and habitat preferences. In addition, FWS suggests that gradients of VHG are important and should be evaluated.

Comments on Requested Study Modifications

AEA disagrees that VHG was not considered in association with spawning salmon. AEA indicates that HSC spawning surveys include both randomly selected and historical spawning locations to ensure that spawning would be observed and areas with no spawning activity. AEA states that it collected more than 650 VHG measurements during spawning surveys with more than half of all measurements made in randomly

selected sites. HSC samples were classified into three categories: (1) upwelling if the measured VHG was positive, (2) downwelling if the measured VHG was negative, and (3) neutral if the VHG was zero. AEA states that micro-piezometer measurements were successfully used to detect the presence of groundwater upwelling/downwelling within HSC sampling sites and near spawning redd locations. Upwelling VHG was included as a habitat variable (of those collected synoptic with HSC) used in the statistical analysis to predict fish presence-habitat use. For HSC curve development, AEA classified VHG measurements into three categories (upwelling, neutral, and downwelling) and then refined this to two categories (upwelling, no-upwelling) because few (<6%) sample locations had negative VHG and because less spawning occurred at downwelling sample locations than at VHG neutral sites. AEA states that it will continue to evaluate the scale and specific influence of groundwater upwelling/downwelling in habitat selection by spawning chum, sockeye, and pink salmon and will coordinate with study 7.5 to determine if groundwater mapping efforts can be used to shed additional light on the relationship between groundwater and spawning site selection.

Discussion and Staff Recommendation

AEA's HSC/HSI development for VHG is ongoing; therefore, available information is insufficient at this point in the HSC/HSI development process to determine whether meaningful gradients exist (or not), and whether AEA's proposal to group VHG categories (e.g., neutral and downwelling) is appropriate. Therefore, we recommend that AEA continue to collect VHG measurements during the next year of study to supplement existing data and reassess the potential influence of VHG over the range of measurements. We also recommend that AEA evaluate VHG as a continuous variable related to upwelling and downwelling to determine whether a strong gradient relationship exists between VHG and habitat use and suitability and report the findings in the USR. This will inform the potential uncertainty in the ability of the groundwater model to inform habitat suitability. If a strong gradient relationship is evident, AEA should consider using a fitted continuous model to develop HSC for VHG as a microhabitat variable and assess whether the resolution of the groundwater model will be sufficient to analyze project effects.

Other Habitat Suitability Criteria Microhabitat Variables

Requested Study Modifications

FWS disagrees with AEA's proposal to remove macronutrients, dissolved organic carbon (DOC), alkalinity, and chlorophyll-a from further sampling and analysis for HSC development and instead recommends that AEA continue to sample the full suite of microhabitat variables specified in the April 1, 2013, study plan determination, including depth, velocity, substrate, proximity to cover, upwelling, turbidity, surface flow and groundwater exchange fluxes, DO (intragravel and surface water), temperature

(intragravel and surface water), pH, macronutrients (i.e., nitrogen and phosphorus), DOC, alkalinity, and chlorophyll-a.

Comments on Requested Study Modifications

AEA states that it will continue to collect HSC data during ongoing HSC sampling events. However, AEA asserts that its analyses to date demonstrate which microhabitat variables show predictive value and should be included in the HSC model as continuous predictors. Of the eight additional variables that it was required to evaluate in the approved study plan, its initial data collection and analyses suggest that macronutrients, DOC, alkalinity, and chlorophyll-a are not good predictors of fish habitat use; therefore, it proposes to eliminate these four variables from further data collection and analyses for HSC development under study 8.5.

For macronutrients, AEA states that its results from 2013 samples were inaccurate, likely due to the effects of high turbidity. Although AEA indicates that it may be able to identify a correction factor that would enable the use of the 2013 data, it does not propose doing so. AEA asserts that, although no site-specific macronutrient data are available, it is widely believed that the concentration of nitrogen and phosphorus does not relate directly to fish abundance because it must first be assimilated into the food web before fish can use it (Nakano and Murakami, 2001; Meyer et al., 2007). Furthermore, AEA contends that the rate of nitrogen and phosphorus assimilation varies over space and time, making it unrealistic to believe that the water quality model can predict changes to total nitrogen and phosphorus concentrations within all macrohabitat types of a Focus Area on an hourly or daily time-step in response to changes in project operation.

For DOC, AEA states that no evidence suggests that DOC can be used as a predictor of fish abundance or habitat use in the Susitna River as shown in its comparison results presented in table 3.2-2 of the *Evaluation of Relationships between Fish Abundance and Specific Microhabitat Variables Technical Memorandum*. AEA states that DOC data were collected as part of study 5.5, and DOC levels show considerable spatial and temporal variability depending on sample location and assimilation into the trophic food web. AEA asserts that a more meaningful indicator of the influence of DOC on fish abundance might be macroinvertebrate productivity (relative abundance) and species richness, but AEA does not propose any further study for this variable.

For alkalinity, AEA indicates that only 19 samples were available where alkalinity and fish distribution and abundance (FDA) sampling overlapped from which to evaluate a relationship between alkalinity and fish abundance. AEA states that in most riverine fish populations, alkalinity of water alone is not known to have a significant, direct effect on fish; however, the results of its statistical analysis show a weak relationship between alkalinity levels and both resident and non-resident salmonid abundance. Nevertheless, AEA states that because alkalinity levels are not being collected or modeled on a Focus Area scale and the relationship between alkalinity and fish abundance was generally weak, no further study for this variable is warranted.

For chlorophyll-a, AEA indicates that chlorophyll-a levels are generally not considered a direct indicator of fish abundance (particularly for salmonids) or habitat use, but rather an indicator of overall water quality and productivity. AEA indicates that modeling showed a strong relationship between chlorophyll-a and resident, non-salmonid fish species abundance and suggest this is likely due to algae consumption by these fishes. However, AEA does not propose to develop HSC curves for fish habitat suitability for chlorophyll-a, but rather it proposes to assess project effects on benthic macroinvertebrates and algae using HSC curves developed for benthic macroinvertebrates and algae from the *River Productivity Study* (9.8).

Discussion and Staff Recommendation

Regarding FWS's recommendation to continue to pursue HSC development for all variables recommended in the April 1, 2013, study plan determination, we recommend that AEA continue to collect HSC/HSI data for those microhabitat variables that it proposes during the next year of study and update HSC/HSI models accordingly. The four variables that AEA proposes to eliminate from further HSC development are discussed below.

For the reasons stated above by AEA, we agree that it is appropriate to eliminate DOC and macronutrients from further data collection and analyses for HSC development under study 8.5.

However, we do not recommend approving AEA's proposal to eliminate alkalinity and chlorophyll-a from further data collection and analyses for HSC development under this study. AEA's limited sampling results for alkalinity collected to date suggest a relationship between alkalinity and both resident and non-resident salmonids (see table 3.2-2 of *Evaluation of Relationships between Fish Abundance and Specific Microhabitat Variables Technical Memorandum*, dated September 2014). However, because the limited results are inadequate to make definitive conclusions, it would be premature to eliminate alkalinity from further HSC development under study 8.5 at this time. Instead we recommend that AEA continue to collect field data for alkalinity during the next study season and continue to evaluate whether meaningful relationships with fish abundance exist. The results of this comparison should be presented in the USR.

With regard to chlorophyll-a, based on our review of table 3.2-2 of the *Evaluation of Relationships between Fish Abundance and Specific Microhabitat Variables Technical Memorandum,* it appears that a relationship exists between resident non-salmonid fish abundance and chlorophyll-a; therefore, it would be premature to eliminate chlorophyll-a from further fish habitat HSC development at this time. Instead, we recommend that AEA continue to collect field data for chlorophyll-a during the next study season and use the data to further evaluate whether meaningful relationships with fish abundance exist. The results of this comparison should be presented in the USR.

Using Statistical Methods for Habitat Suitability Criteria Development

Requested Study Modifications

NMFS and FWS contend that the study must be modified to use statistical methods to identify which criteria are ecologically relevant to fish habitat selection and then develop HSC models for the relevant criteria. NMFS and FWS assert that AEA's use of exploratory univariate models to assist in identifying habitat variables for multivariate modeling is not appropriate, and although NMFS and FWS do not recommend any other specific methods in lieu of AEA's approach, both agencies believe that other methods would be more appropriate for this analysis.

Comments on Requested Study Modifications

AEA disagrees with the agencies' requested modification and states that its methods for developing HSC/HSI include multivariate statistical models that represent select life stages of high priority fish species. AEA states that it used a stratified random sampling approach based on macrohabitat composition within each Focus Area and relative fish use for selecting sampling locations, with some adjustments made to final locations based on access and safety considerations. AEA suggests that this approach enables representative sampling of the range of macrohabitat types available within Focus Areas and ensures that diverse habitats are sampled.

AEA states that model fitting for mixed effects models can be unstable if too many variables are included in a global model. AEA suggests that habitat variables are generally considered to co-vary and therefore cause multicollinearity issues. AEA indicates that for these reasons, the variables to include in the global model were reduced by fitting univariate models to look for relationships prior to producing the global model and believes this to be a sound statistical process.

Discussion and Staff Recommendation

We disagree with NMFS's and FWS's contention that using a univariate utilization curve generation process to perform exploratory analyses to assist with identifying habitat criteria for use in multivariate modeling is an invalid way to select criteria. Using univariate models to identify relationships before incorporating into multi-variable (or global models) is common practice (section 5.9(b)(6)) and avoids potential issues with model instability associated with having too many variables, as well as multicollinearity issues associated with habitat variables co-varying. We find that AEA's approach to developing HSC is reasonable and consistent with the approved study plan. Therefore, we do not recommend requiring AEA to adjust its approach for evaluating the relationships between fish abundance, habitat use, and the influence of microhabitat variables.

Unoccupied Habitats

Requested Study Modifications

NMFS and FWS recommend that AEA survey available unoccupied habitat in habitats similar to those occupied so that ecologically and statistically valid comparisons can be made.

Comments on Requested Study Modifications

AEA states that surveys of available habitat were performed in habitats immediately adjacent to occupied habitats, both laterally and longitudinally, within the same habitat units that were utilized. AEA contends that this modification request is based on faulty information and apparent confusion regarding sampling scale. AEA states that identifying and sampling unoccupied habitats as NMFS and FWS request would first require that the site be sampled to determine if fish were present, and if so, then another site would need to be selected until an unoccupied site in an identical macrohabitat could be located. AEA indicates that this type of sampling was not part of the approved study plan, and NMFS and FWS have not established "good cause" to modify the study plan to require it.

Discussion and Staff Recommendation

AEA indicates that it selected HSC sampling locations based on the habitat stratification/classification system consistent with the approved study plan. The sampling sites included areas with fish present and not present, and microhabitat utilization and availability data were collected at each sampling event. Therefore, AEA is already sampling available unoccupied habitats, and we do not recommend requiring AEA to adjust HSC/HSI sampling methods to identify and sample additional unoccupied habitats beyond what it already proposes.

However, we do recommend that AEA include in the USR a summary of the results of site selection to understand how the selected sample locations are distributed within the hierarchical channel classification framework. This could be provided as an update to the ISR, part A, section 5.5.3. We recommend the summary include the number of HSC sampling sites (by species, life stage, and season) selected within each mesohabitat type, macrohabitat habitat type, geomorphic reach, and river segment. For each sampling location, AEA should indicate whether it was selected randomly or non-randomly, the date (or season) each site was sampled, and whether the site was occupied or unoccupied for each species and life stage for which HSC/HSI were being developed. This information will help NMFS and FWS understand the distribution of sample locations within the hierarchical channel classification framework to assess relative sample frequency within the sampling framework and will indicate whether significant data gaps may exist. As NMFS, FWS, and AEA note in their prior comments on this study, there is a lack of understanding regarding how (or if) the hierarchical channel

classification system was used to select HSC sampling locations, and the specific information needed to evaluate the results of implementing this approach have not been reported. This would be a low-cost (section 5.9(b)(7)) reporting requirement that would improve our understanding of the methods used to select sites for sampling HSC/HSI, and how the selected sites are distributed within the sampling framework outlined in the approved study plan.

Groundwater and Inter-gravel Water Quality

Requested Study Modifications

NMFS and FWS recommend that AEA increase sampling effort of subsurface (inter-gravel) water temperature and DO measurements at each Focus Area to increase the understanding of habitat requirements for chum salmon spawning and incubation. NMFS and FWS also recommend that these data be integrated with the 3-D groundwater models to develop HSC curves and complete the WUA analyses for salmon spawning.

Comments on Requested Study Modifications

AEA states that it has already collected an extensive array of surface and inter-gravel temperature data, surface DO data, and inter-gravel DO data within known spawning areas in accordance with the approved study plan (see RSP section 8.5.4.5.1.2.1). AEA states that the existing data collection efforts will meet study objectives and that increasing the sampling effort of subsurface water temperature and DO measurements at each Focus Area as NMFS and FWS recommend would cost approximately $300,000–$400,000.

Discussion and Staff Recommendations

NMFS and FWS suggest that increasing the sampling effort for inter-gravel water temperature and DO could be used to improve the resolution of the 3-D groundwater model, and the 3-D groundwater modeling results could be used as a predictive tool to inform HSC development. However, AEA's approach for developing HSC for salmon spawning as required by the approved study plan does not require it to develop predictive groundwater models. In addition, NMFS and FWS do not provide sufficient information on how 3-D groundwater models could be incorporated into HSC development for salmon spawning, and we are not aware of any way that such an approach could be incorporated into AEA's HSC development process (section 5.9(b)(6)). Therefore, we do not recommend requiring AEA to collect additional groundwater data and incorporate such data into a 3-D groundwater model for salmon spawning HSC.

Breaching Flows and Habitat Connectivity Analysis

Requested Study Modifications

NMFS and FWS recommend that AEA expand the breaching flow and habitat connectivity analysis to encompass biologically relevant timelines, such as every five years, which is the average generational lifespan of a Chinook salmon. NMFS and FWS contend that the breaching flow analysis should include both main channel and lateral habitats because these habitats support critical life stages, including spawning, incubation, rearing, and migration.

FWS also recommends expanding the breaching flow analysis to include the predicted channel geometries at the 25 and 50 year intervals after initiating project operation, as well as at other unspecified intervals where the geomorphology modeling results show significant channel change.

Comments on Requested Study Modifications

AEA states that breaching flow and habitat connectivity analyses are already included as part of the approved study plan; however, developing separate analyses at 5- and 10-year time frames would cost approximately $65,000–$75,000.

AEA states that the breaching flow analysis will include an analysis of conditions for year 0, year 25, and year 50 to quantify anticipated project effects. A 50-year, continuous period of record will be used for 1-D modeling, with shorter modeling periods for the 2-D model because of computational limitations. The 1-D model will be applied to address the analysis of reach-scale issues and the 2-D model to address local-scale issues.

Discussion and Staff Recommendations

We see no reason to require AEA to expand the habitat connectivity and breaching flow analyses to a more-frequent interval, such as every five years, at this time. Requiring it to do so now would increase the cost of the study (section 5.9(b)(7)) and would be premature because the results of the analyses at a broader time step to determine the magnitude of change between these intervals are not yet available. Instead, a more reasonable approach would be to evaluate the magnitude of change between the existing condition and years 25 and 50 using the results presented in the USR and determine at that time whether the results are sufficient to inform our analysis of project effects and develop license requirements (section 5.9(b)(4)), or if a more frequent interval is needed. Therefore, we do not recommend any modifications to the study plan.

Stranding and Entrapment

Requested Study Modifications

NMFS and FWS recommend that AEA thoroughly address the ability to model stranding and trapping under the rapid and perpetual flow fluctuations in side channels and side sloughs during proposed winter flows.

Comments on Requested Study Modifications

AEA states that TWG meeting participants indicated that site-specific stranding and trapping studies should be a low priority because the project does not yet exist, and the effects of project-induced flow fluctuations cannot be directly studied in the Susitna River. AEA indicates that stranding and trapping indices use results of the flow routing models to determine the water surface elevations on an hourly basis within Focus Areas. AEA contends that stage fluctuations are applied within Focus Areas using the digital terrain models to quantify the frequency, timing, and magnitude of stranding events. AEA states that the results of the mainstem flow routing models and the digital terrain models are also combined to quantify the frequency, timing, and duration of trapping events for discrete channel features within Focus Areas.

Discussion and Staff Recommendations

The effects of project-induced flow fluctuations during winter may have a substantial impact on aquatic resources in the Susitna River downstream of the proposed dam. Ramping rate restrictions proposed by AEA (e.g., Hunter, 1992) for use in developing operational scenarios will reduce potential risk of stranding; however, these restrictions will not eliminate the potential effect of project-induced flow fluctuations on stranding and trapping during winter. In addition, ramping rate restrictions do not account for potential effects of dewatering on early developmental life stages (e.g., egg, alevin, and pre-emergent fry) or older life stages when residing within substrate interstices during winter.

As noted by AEA, site-specific field studies of stranding and entrapment under current conditions may be of limited value for evaluating stranding and trapping risk and the potential effects of project operations on aquatic resources post-project, and the TWG participants identified them as low priority. However, while the study plan provides a general description of how AEA will conduct the stranding and trapping analyses, it provides insufficient detail to understand how specifically AEA intends to assess the effects of stranding and entrapment in side channels and side sloughs and other lateral habitats during winter under ice (see RSP section 8.5.4.5.1.2.2). Therefore, we recommend that AEA include in the USR a detailed description of the methods and results of stranding and trapping analyses and present the results of the analyses spatially within Focus Areas by providing maps indicating areas of the relative risk of stranding and entrapment based on results of the analyses using parameters such as frequency, rate,

duration, and timing. We anticipate that this modification would be a relatively low-cost reporting requirement (section 5.9(b)(7)) that would provide useful information to inform our analysis of project effects on stranding and trapping risk in important macrohabitats within Focus Areas and determine whether license requirements to reduce stranding and entrapment risk are needed (section 5.9(b)(4)).

Habitat Persistence for Salmon Holding

Requested Study Modifications

NMFS and FWS recommend that AEA address the need to provide habitat persistence for holding (e.g., at tributary mouths) by developing thresholds for lateral and longitudinal geomorphic habitat change and connectivity and alterations to the hydrograph. NMFS indicates that the coarseness of the HEC-RAS bed evolution model does not seem to allow for such precision.

Comments on Requested Study Modifications

AEA states that the combination of 1-D and 2-D hydraulic modeling will provide depth, velocity, water surface elevation, and other parameters over the range of hourly flows. AEA indicates that 2-D modeling within Focus Areas uses a 2-D mesh with the typical resolution (side length of the triangular and quadrilateral elements) of 6 feet (2 meters) in the fine mesh areas identified by the instream flow study team and suggests this will be sufficient for the evaluation of holding areas.

AEA states that habitat persistence is an important component of project effects evaluations and has proposed both habitat time series and effective habitat time series as evaluation metrics. AEA indicates that the selection of final habitat metrics and appropriate time steps will be developed in consultation with the TWG.

Discussion and Staff Recommendations

NMFS and FWS do not provide sufficient detail regarding thresholds for geomorphic or hydrologic changes to determine how the thresholds would be identified, used, or how they would provide additional information to inform the analysis of potential project effects on holding habitat at tributary mouths. AEA's proposed methods of combining the 1-D and 2-D hydraulic models within Focus Areas to inform the effective habitat time series analysis should be sufficient to meet the study objectives of assessing habitat persistence of adult holding habitat at tributary mouths and elsewhere (section 5.9(b)(1)). Therefore, we do not recommend any modifications to the study plan.

Study 8.6 – Riparian Instream Flow

Background

The objective of the study is to develop a spatially explicit model to predict changes in riparian vegetation under different project operation scenarios. To meet this objective, the study requires data collection to identify (1) environmental conditions and processes that produce sexual and clonal regeneration, and (2) riparian vegetation use of surface water and groundwater. AEA collected seedling establishment and survival data for 2013, 2014, and 2015. AEA collected sap-flow and stomatal conductance evapotranspiration (ET) data in 2013 and 2014.

Requested Study Modifications

NMFS states that the delay created by the placing the ILP in abeyance creates an opportunity to gather additional data on survivorship in the seedling recruitment plots when the project resumes and that the increased time span between establishment and re-measurement would make growth trends easier to detect. NMFS states these data would be useful in determining what locations are likely to result in ultimate pole-sized and mature tree recruitment and to identify the importance of clonal reproduction in recruiting mature stands. Additionally, NMFS notes that the 2012–2013 snowpack was abnormally large and led to anomalous groundwater levels and growing conditions in spring 2013 that may have affected seedling survival. These conditions further support the need to gather additional data on seedling survival when the project resumes. NMFS adds that the seedling establishment and recruitment component of the study is not complete because AEA did not track seedling survival over winter or to the point of reproductive maturity.

Comments on Requested Study Modifications

AEA agrees that 2013 was characterized by prolonged winter conditions and an unusually late arrival of spring conditions. However, AEA states that the predominant riparian vegetation communities are perennial plants that are adapted to the type of natural meteorological variability exhibited in 2013. AEA contends that the conditions in 2013 were within the range of variability over the 67 years of record. AEA states that the seedling establishment and recruitment study was implemented following the approved study plan and that revisiting study plots in the future is not possible because they were removed from the sample sites upon completion of the study in 2015 and cannot be accurately reinstalled. Further, AEA states that delays in the ILP do not constitute "good cause" per the ILP regulations to modify a FERC-approved study plan to extend the years of data collection.

Discussion and Staff Recommendation

Compared to the peak flow history of the Susitna River at Gold Creek, the 90,800-cfs flow that occurred in early June 2013 was one of the highest flows on record. However, it is far from an outlier. Between 1962 and 1972, high flows over 80,000 cfs occurred in five years and flows over 90,000 cfs occurred in one year. The June 2003 flow event likely created more suitable conditions for poplar, willow, and alder seedling establishment than has occurred in the last 10 years.

However, the intent of the study is to track seedling survival over a three-year period, which was conducted during 2013, 2014, and 2015. The 2013 spring flood occurred just as trees were setting seed and may have increased seedling establishment and survival during the first few weeks following seed dispersal and germination because the flood provided wetted sediment deposits suitable for germination. Following this initial seedling establishment, sediment erosion and deposition from subsequent flood events and ice scour are the primary sources of seedling mortality and no weather anomalies occurred during 2014 and 2015 that would have influenced second and third year seedling survival. Therefore, the 2012–2013 weather conditions do not provide a good cause for extending the study (section 5.15(d)(2)). The results are consistent with similar work reported in the scientific literature (Stromberg et al., 1993; Rood et al., 1998) and provide seedling survival rates for input into the model predicting riparian vegetation response to project operation scenarios. Further, it is not possible to follow seedling survival at some time in the future because the sample plots were removed. We conclude that AEA followed the study plan, and the results provide sufficient information to meet the study objectives (sections 5.15(d)(1) and (e)(2)); therefore, we do not recommend modifying the study to require additional data on seedling establishment and survival.

Study 9.5 – Study of Fish Distribution and Abundance in the Upper Susitna River

Background

The primary goal of this study is to describe the distribution and relative abundance of the current fish assemblage in the Susitna River and tributary streams upstream of the proposed Watana Dam at PRM 184. The study is also intended to provide information on the distribution and periodicity of different life stages of fishes for use in the physical habitat modeling efforts and fish passage evaluations under study 8.5, the *Fish Passage Feasibility at Watana Dam Study 9.11,* and the *Fish Passage Barriers in the Middle and Upper Susitna River and Susitna Study 9.12*.

The study has the following major components that are relevant to this determination: (1) describe the seasonal distribution, relative abundance (as determined by catch per unit effort [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 using a variety of gear sampling types in both the mainstem,

within the reservoir inundation zone, and in tributaries to the reservoir site; and (2) describe seasonal movements of juvenile Chinook salmon and other fish species using downstream migrant traps, passive integrated transponder (PIT) tags, and radio tags.

In addition to the study description in the RSP, AEA also prepared a FDA Implementation Plan that was approved by the Commission and provides additional information on the sampling strategy, study site selection process, and field sampling procedures.

AEA initiated some pilot sampling in the Upper River in 2012 to refine its proposed sampling methods and completed the first year of sampling during the ice-free period in 2013 (July through October). AEA completed some additional sampling in 2014 and proposes to complete another year of sampling for many study components during the next study season. However, some study components such as radio-tagging are complete, and AEA does not propose any additional study efforts.

Statistical Comparisons of Abundance

Requested Study Modifications

NMFS recommends the study plan be modified to include a description of how the data will be converted into quantitative estimates so that rigorous comparisons can be made across species, river habitat types, and time. NMFS argues there should be a tight linkage between the sampling design and the estimates and statistical inferences drawn from the plan. NMFS recommends use of statistical tests to determine if differences in mean relative abundance measures are significantly different among habitat classifications at all classification levels.

FWS also recommends that AEA provide a comparison of counts across sampling methods so that comparable abundance estimates can be made across gear types. FWS states that AEA's approach of using multiple gear types to determine fish abundance and distribution across a diversity of habitat types remains problematic; different sampling gear-types have resulted in different, non-comparable measures of abundance.

The Alaska Department of Fish and Game (Alaska DFG) comments that across habitat comparisons are unrealistic for CPUE data collected with different gear types in different habitats.

Comments on Requested Study Modifications

AEA argues that rigorous statistical comparisons and standardized abundance estimates across multiple gear types is not required by the approved study plan and is not necessary to meet study objectives. AEA contends that the approved study was designed to provide a descriptive baseline characterization of fish distribution and relative abundance over several hundred miles of habitat and was not set up to provide definitive population estimates of multiple species and life stages of fish in different habitats or

across time. AEA states that to achieve the study objectives, it only needs to describe relative abundance and fish-habitat associations using more general fish counts, density estimates, and CPUE estimates by each gear type. However, AEA indicates that, although it was not a requirement of the study plan, it is developing and refining a tool to standardize abundance estimates across the various gear types to enable a better comparison of fish abundance across species, habitat types, and seasons.

Discussion and Staff Recommendation

While the level of sampling effort and data analysis sought by FWS and NMFS would be useful to develop definitive estimates of abundance for each species and habitat type, this level of statistical precision is not needed to describe fish distribution and relative abundance for the purposes of a hydroelectric project licensing study that will be used to inform a NEPA analysis and develop license requirements (section 5.9(b)(4)). We agree with AEA that it can meet the study objectives of describing fish distribution and relative abundance by providing fish counts, CPUE, and fish density by species and habitat type, as specified in the approved study plan and is customary in hydroelectric licensing studies (section 5.9(b)(6)). Therefore, we do not recommend modifying the study to increase the statistical precision of its abundance estimates.

Nevertheless, while it is not needed for our analysis, if AEA is successful in standardizing abundance estimates across all sample gear types, such information may improve our understanding of the fish assemblages in the river and different habitat types. Therefore, we would have no objection to AEA continuing to develop its methodology as it proposes.

Consistent Sampling Gear Types for Mainstem Sampling

Requested Study Modifications

NMFS suggests that AEA implemented inconsistent sampling methods and sampling effort among sampling locations and that these inconsistencies have compromised the accuracy of the data and complicated the data analyses. Therefore, NMFS recommends that AEA complete two more years of sampling and implement consistent methods for selecting mainstem sampling locations and sampling gear types.

FWS states that the efficiency of each sampling gear type should be evaluated and compared so counts among sampling methods are comparable, interactions between sampling methods can be understood, and future sampling activities can be made more efficient. If such comparisons prove to be difficult or highly variable, then FWS recommends that sampling gear be limited to the most effective gear types and deployment of this gear remains consistent.

In their comments on studies 9.5 and 9.6, NMFS also makes the following recommendations with respect to how AEA should select or deploy its various gear types during FDA sampling:

- fyke nets, hoop traps, and beach seines should not be used to derive estimates of relative abundance; and
- following minnow trapping, backpack electrofishing should be used to obtain abundance estimates of salmon fry and resident fish species that are not effectively captured in minnow traps (sockeye, chum, and pink salmon).

Comments on Requested Study Modifications

AEA states that its methods for selecting gear types are consistent with the approved study plan and are sufficient to meet the study objectives. AEA contends that many factors influence the effectiveness, suitability, and selection of gear type, including but not limited to: depth, velocity, substrate, snags, water clarity, water conductivity, the species and life stages present, and the presence of spawning salmonids. AEA states that it selected the most appropriate method for sampling each mainstem habitat unit at the time of sampling according to its gear-type selection protocol, which it has refined over the study period. AEA indicates that environmental conditions change throughout the study area, and that its approach for selecting gear types allows for some flexibility to enable it to select the best methods for sampling given the dynamic nature of environmental conditions and diversity of habitat types.

AEA disagrees with FWS's recommendation to test the efficiency of each sampling gear type. AEA contends that gear efficiency varies by species, life stage, diet, and habitat conditions when and where the gear is used. AEA argues that gear efficiency would add information about counts, but it would not, by itself, provide additional information to support comparisons across habitats where efficiency varies. In addition, AEA states that only comparing data in habitats where gear efficiency is similar would severely limit its ability to characterize the complex riverscape and fish assemblages.

AEA disagrees with NMFS's contention that fyke nets, hoop traps, and beach seines should not be used to estimate relative abundance and that only minnow traps and backpack electrofishing are generally accepted methods and should be used for this purpose. Although limiting gear types would make relative abundance calculations simpler computationally, the variable efficiency of those gear types across the diverse habitats of the Susitna River would prevent those estimates from being comparable. For example, if AEA adopted this modification and backpack electrofished in turbid riffles with low visibility and low conductivity, CPUE estimates could be statistically compared to CPUE estimates from clear water glides with moderate conductivity, but that analysis would not be an accurate reflection of any differences in fish assemblages because the CPUE would be affected by the drastically different sampling conditions at each site. AEA asserts that, in this case, numerical precision and computational ease should not be confused with accuracy. AEA maintains that the most accurate description of relative abundance will be generated by using the most effective gears in each habitat type, as described in its gear-type selection protocol.

Discussion and Staff Recommendation

Although the agencies make some recommendations for gear types that they contend would be better suited for sampling some species and habitats than those chosen by AEA, neither NMFS nor FWS propose a specific gear type that would be the most effective for sampling the full range of fish species and habitat types under all environmental conditions. Therefore, it is difficult to evaluate the agencies' proposal against AEA's approach of selecting gear types at the time of sampling according to its defined gear-type selection protocol.

Testing gear type efficiencies and requiring AEA to use the most-efficient gear type based on the efficiency test, as recommended by FWS, would be one method for streamlining the gear types and improving consistency among sampling methods. However, imposing a strict requirement that a potential license applicant only use the "most efficient" sampling method when selecting a gear type for FDA sampling is not customary in hydroelectric licensing studies (section 5.9(b)(6)). In addition, the efficiencies of each gear type would likely vary by fish species, life stage, season, and multiple interacting habitat conditions, and it would be difficult and costly to continue to run efficiency tests to find the "most efficient" gear type prior to each sampling event.

The fish assemblage and habitat types of the study area are diverse, and environmental conditions are constantly in flux. Requiring AEA to use fewer sampling gear types to improve consistency among methods would likely eliminate some of its flexibility in choosing methods that best match the species, habitats, and environmental conditions encountered at a given sampling site and would not likely result in a better outcome. Instead, we find that AEA's procedures for selecting gear types for mainstem sampling are consistent with the methods specified in the approved study plan and are a reasonable and accepted approach for choosing the most effective sampling method within a variety of habitat types and frequently fluctuating environmental conditions (section 5.9(b)(6)). At this point, AEA appears to be on track to meet the study objectives (section 5.9(b)(1)) and provide the necessary information on FDA to inform our analysis and develop license requirements (section 5.9(b)(4)). Therefore, we do not recommend requiring AEA to evaluate the efficiency of each sampling gear type or modify its sample site selection or gear type selection process to improve consistency in its sampling methods.

Expanding Study Area and Sampling Effort

Requested Study Modifications

NMFS and FWS recommend expanding sampling to include the mainstem and tributaries upstream of the reservoir inundation zone. NMFS argues that new information now proves salmon occur above the site of the proposed dam; therefore, salmon distribution and abundance sampling should occur in the mainstem and tributaries above the proposed reservoir to document existing conditions in areas that would potentially be

altered directly, indirectly, or cumulatively by the proposed project. NMFS states that an accurate description of the current distribution of anadromous fish species and factors that may influence the evaluation of fish passage alternatives is required to determine the need for fish passage protection measures for anadromous fish species and to inform the design of fish passage facilities.

Similarly, in its comments on study 9.11, NMFS recommends that AEA determine the number of tributaries above the reservoir where target fish species spawn. NMFS states that, without this information, the scale and cost of any fish passage facilities and their operations are unknown.

In its comments on study 9.11, FWS contends that AEA's statement in the ISR that "Upper River Catch Per Unit Effort (CPUE) averages for juvenile Chinook salmon were similar in magnitude to estimates of CPUE for Middle and Lower River sites" indicates that a larger percentage of the Chinook run is migrating to the upper river than the radio tagging program indicates. FWS suggests that the timing of juvenile catch efforts should be modified, and at least two additional years of study are needed to confirm the abundance and distribution of the Upper River Chinook population.

Comments on Requested Study Modifications

AEA states that it is difficult to estimate the effort sought by the agencies because they do not provide any details on where and how intensively sampling would occur in the Upper River. AEA states that seasonal sampling above PRM 235.1 (current limit of study boundary) to the East Fork of the Susitna River at a similar level of effort to its existing program would include an additional 20 selected tributary streams and 76 miles of mainstem sampling using a Generalized Random Tessellation Stratified (GRTS) approach. AEA states that this would also require installing and operating a downstream migrant trap on the mainstem Susitna River upstream of the Oshetna River, and that the additional cost of these modifications would be $3,200,000.

AEA states that the agencies have not established good cause for expanding the study. AEA contends that only one radio-tagged adult Chinook salmon moved upstream of the Oshetna River confluence at PRM 235.1 out of 1,577 tagged in the Middle River over a three-year period. Although this fish traveled extensively upstream of the inundation zone in the Susitna River, it did not move into any tributaries for a sufficient length of time to provide evidence of spawning or rearing this far upstream. AEA states that this one data point indicates that individual salmon may explore upstream habitats but argues that it does not justify expanding studies for spawning or rearing Chinook salmon in the reaches upstream of the Oshetna River. AEA states that estimated counts of adult Chinook salmon through radio-tagging, nine years of aerial spawning surveys (1982–1985, 2003, 2011–2014), and sonar at the Watana Dam site indicate that very few individuals migrate upstream of the proposed dam site and that the primary spawning tributaries are Kosina Creek and the Oshetna/Black River, which it is already sampling under study 9.5.

Discussion and Staff Recommendation

The approved study plan requires fish sampling within the proposed reservoir inundation zone of the mainstem Susitna River and in tributaries to the reservoir inundation zone up to the 3,000-foot elevation contour. This is a substantial sampling effort, and we expect that had there been many juvenile salmon originating in or upstream of the inundation zone and migrating downstream through the proposed reservoir, they would have been encountered by AEA's study efforts. The results to date suggest that Chinook salmon abundance throughout the Upper River study area is low. With the exception of one individual adult Chinook salmon that was documented in the mainstem above the reservoir during radio tagging as part of study 9.7, AEA has only documented adult or juvenile Chinook salmon above the dam site in the mainstem within the reservoir inundation zone, in Kosina Creek, and in the Oshetna/Black River system, despite numerous efforts through this study and study 9.7 to identify them elsewhere. Based on this, we conclude that no evidence exists (section 5.9(b)(4)) to suggest that Chinook salmon are spawning or rearing in substantial numbers in the mainstem above the Oshetna River confluence, and we therefore, have no justification for requiring AEA to expand its fish sampling to include additional mainstem or tributary habitats upstream of the reservoir inundation zone.

Extended Study Duration and Survey Timing

Requested Study Modifications

NMFS and FWS recommend that AEA implement the study for a minimum of two years to determine if study objectives have been met. NMFS indicates that it is concerned that sampling conducted during "recent anomalous weather patterns" does not accurately represent Susitna River baseline resources, and thus would not serve as an adequate basis for assessing any future project effects. NMFS states that the Susitna watershed experienced unusually high levels of flooding in 2012 and 2013, followed by unusually warm temperatures in the winters of 2014–2015 and 2015–2016. NMFS reiterates its prior comments that a minimum of five years of data are needed to determine the migration pattern of salmonids and the environmental factors influencing migration.

NMFS and FWS also recommend modifying the study to include sampling at all FDA sites during early spring following ice breakup (May or early June), twice during the summer (July–August), and in the fall (mid-September to early October). NMFS and FWS assert that AEA did not conduct spring sampling at all sample sites as proposed in the FDA Implementation Plan, and instead it only conducted limited spring sampling in select tributaries. Therefore, because spring sampling was not conducted in mainstem sites, it is unknown whether juvenile Chinook salmon moved from spawning streams to mainstem overwintering locations as previously documented in the Middle River (i.e., juveniles migrating from the Indian River to the mainstem). NMFS and FWS also

contend that the lack of spring sampling data at all FDA sites makes it impossible to identify whether resident fish moved into tributaries or overwintered in tributaries or in the mainstem.

Comments on Requested Study Modifications

AEA states that the Upper River has been subject to intensive study of Chinook salmon distribution for both juveniles and adults in studies 9.5, 9.7, and 9.8, and that two years of data collection under the Commission's ILP process is sufficient for baseline characterization of aquatic resources to support an analysis of project effects. AEA indicates that it collected data for this study in the Upper River in 2012, 2013, and 2014 and is proposing to complete an additional year of sampling during the next study season.

AEA agrees that it is important to gather additional information on the timing of juvenile Chinook salmon movements from spawning to rearing areas and out of natal tributary streams. As proposed in the ISR, part D, AEA asserts the most effective approach to gather this information is to review the existing information and design a targeted Chinook salmon early life history (ELH) sampling program initiated as soon as feasible following breakup and to continue to install and operate downstream migrant traps. However, AEA indicates that it would not be effective or necessary to implement a randomized study design with bi-weekly sampling that is comparable to the summer and fall FDA sampling program because the intent of the intensive spring sampling is to gather information on Chinook salmon behavior immediately following ice-out, and NMFS's recommended modification would not be effective in gathering this specific information because few Chinook salmon occur elsewhere in the Upper River outside of documented spawning tributaries. Additionally, AEA asserts that expanding the spring sampling to all sampling areas (rather than just focused sampling within known Chinook salmon spawning tributaries) would be ineffective because of the difficulty in sampling mainstem habitats during the flooding associated with ice breakup and initial snowmelt.

Discussion and Staff Recommendation

The approved study plan requires AEA to implement its Upper River sampling for two years, which includes two open-water seasons from May to October. Each year's sampling is to occur twice during the summer (once in early July and again in August) and once in the fall (mid-September or early October) at the FDA sample sites. Although AEA did not complete sampling at all locations during all three sampling years, AEA's sampling to date has generally covered a minimum of one year's sampling during each season at all sites. Because AEA proposes to complete an additional year of sampling during the next study season, it appears to be on track to meet the study objectives (section 5.9(b)(1)) and complete two years of sampling as specified in the approved study plan.

Although there were high flows in 2012 and 2013 and warm winters in 2014 and 2015, we find that environmental conditions during these years were within the normal

range of environmental variation and generally did not prohibit AEA from completing its data collection. In those cases where environmental conditions affected sampling, AEA resumed sampling when conditions allowed and/or implemented sampling as proposed during the next study season. Any sampling in a remote and challenging study environment such as the Upper River will always be dictated by flow, weather, and ice conditions. Finding ideal sampling conditions in such a dynamic system is impracticable because AEA would need to begin mobilizing its field crews several weeks in advance of a sampling event, and environmental conditions can change rapidly in the period between mobilization and the sampling event. Requiring AEA to complete an additional year of sampling in addition to what it already proposes would not necessarily result in a different or better data set because adverse environmental conditions that affect study implementation could also occur during any future sampling, especially when sampling spans multiple seasons as is the case here.

Additionally, we see no reason to require AEA to complete five years of FDA sampling. As we said in the April 1, 2013 study plan determination, typically, one or two years of sampling is sufficient to describe the existing environment for FDA, develop fish-habitat associations, and develop aquatic habitat models within the context of a hydroelectric licensing case (section 5.9(b)(6)). At this point, we anticipate that the existing data AEA has already collected plus the additional data it proposes to collect will be sufficient to meet the study objectives (section 5.9(b)(1)) and inform our analysis (section 5.9(b)(4)). Therefore, we do not recommend requiring AEA to modify the study plan to include any additional years of sampling beyond what it already proposes to implement during the next study season.

Further, we see no reason to require that AEA complete early spring sampling at all FDA study sites to be consistent with the remainder of the sampling later in the summer and fall. The intent of AEA's proposed bi-weekly sampling to be implemented in the next study season during the early spring is to attempt to gather specific information on Chinook salmon outmigration behavior immediately following ice-out. Early spring sampling is not intended to sample all FDA study sites nor to identify whether resident fish moved into tributaries or overwintered in tributaries or in the mainstem. Expanding the spring sampling to all FDA study sites, as recommended by NMFS and FWS, would not likely result in more Chinook salmon detections, because Chinook salmon are generally low in abundance throughout the Upper River study area and have only been documented in a few tributaries and the mainstem despite substantial efforts to find them elsewhere. Additionally, expanding the early spring sampling to include the mainstem would likely be ineffective because of the challenging sampling conditions that occur in early spring during breakup (e.g., very high flows and turbidity). We conclude that AEA's approach for limiting early spring sampling to select Upper River tributaries to specifically document juvenile Chinook salmon ELH and outmigration behavior is a reasonable approach that should be sufficient to meet the study objectives (section 5.9(b)(1)), especially when coupled with the data collected through downstream migrant trapping efforts (section 5.9(b)(4)). Therefore, we do not

recommend requiring AEA to expand the early spring sampling to include all FDA sample sites.

Habitat Sampling

Requested Study Modifications

NMFS recommends sampling entire tributary mouths as a macrohabitat that occurs at the confluence of tributaries and the Susitna River or its side channels and states that sampling these habitat features should extend 200 meters downstream as specified in the study plan determination. NMFS states that AEA did not sample the entire tributary mouth as a sampling unit (i.e., beginning at the backwater within the tributary mouth and extending 200 meters downstream) but elected to sample clear water plumes independently from tributary mouths; therefore, AEA did not implement the study as required by the approved study plan.

NMFS also states that slough sampling was not conducted as required by the approved study plan because slough sample units should be 200 meters long, and, in some cases, these sample unit lengths were shorter.

Comments on Requested Study Modifications

AEA states that it determined during the study planning process that tributary mouth and clear water plumes should be characterized and sampled as unique features, consistent with the 1980s Alaska DFG sampling so the results are comparable. AEA also indicates that when present, the influence of clear water plume habitats in the mainstem were highly variable; half (14 of 28) of the plumes sampled in the mainstem were less than the recommended 200-meter sample length, some were as small as 10 meters, and, in rare instances, the plume was dissociated from the tributary because no tributary mouth was present (i.e., water went subsurface). AEA states that the sampling of replicate clear water plumes and tributary mouths was expanded in 2014 with the AEA-proposed modification to implement a hybrid sampling approach in the Upper River.

AEA asserts that NMFS misinterpreted the sample length variance presented in study 9.5, ISR, part A, section 4.1.6.1.1, which states that, when boat electrofishing was not feasible, sampling units were shortened to either the complete mesohabitat unit or 200 meters (656 feet) per mesohabitat type per site, whichever was shorter. AEA states that this was necessary because the level of effort required to effectively cover and gather a representative sample in long units, using other techniques including backpack electrofishing, snorkeling, minnow trapping, and seining, was incompatible with the seasonal sampling goals and the number of sites targeted for sampling given the remoteness of the sampling locations. However, with respect to slough and tributary mouth habitats, AEA indicates that it did sample the entire length of the habitat or 200 meters, whichever was shorter as required by the approved study plan.

Discussion and Staff Recommendation

The approved study plan defines tributary mouth macrohabitats as "clear water areas that exist where tributaries flow into Susitna River main channel or side channel habitats" and requires AEA to classify tributary mouths as Level 3 macrohabitats and clear water plumes as Level 4 main channel or side channel mesohabitats. The approved study plan also requires AEA to sample tributary mouths beginning at the backwater area at the confluence with the Susitna River and continuing for 200 meters downstream. The problem with strict adherence to this approach is that extending the tributary mouth sampling unit a distance of 200 meters downstream could create an overlap with clear water plume mesohabitats or other main channel habitats, thereby having the unintended consequence of replicating the wrong sampling unit. To avoid oversampling mainstem habitats and potentially duplicating sampling efforts, AEA elected to classify tributary mouths and clear water plumes separately and not extend tributary mouth sampling 200 meters downstream where it could extend into mainstem habitat units. This is a reasonable approach that is consistent with AEA's overall sampling and habitat classification system and avoids unintended replication of mainstem sample units (section 5.9(b)(6)). Therefore, we do not recommend requiring AEA to sample tributary mouths beginning at the backwater and extending 200 meters downstream.

In its response to comments, AEA contends that it sampled the entire habitat unit in those units shorter than 200 meters; however, it does not appear as though AEA reported the total length of the habitat features it sampled in the study reports. We recommend that AEA do so in its USR. In conclusion, because AEA completed the sampling as required by the approved study plan, we do not recommend any modifications to the study plan to address slough or tributary mouth sample unit lengths.

Early Life History Sampling

Requested Study Modifications

FWS recommends modifying the study plan to require AEA to implement a complete and rigorous ELH sampling program that better integrates the inter-gravel monitoring component of the ELH studies. FWS recommends that the study focus on the location and timing of Chinook salmon emergence and integrate the ELH sampling with the FDA sampling program to provide an understanding of the early spring distribution of fish species and life stages.

Comments on Requested Study Modifications

AEA opposes the recommended modifications and indicates that such a program could include additional spawning surveys and site identification, incubation monitoring, and sampling for emergence timing, which would require three years to complete, with an estimated implementation cost of between $1,000,000 and $1,500,000. AEA asserts that no nexus exists between inter-gravel temperature and emergence monitoring and

project effects in the Upper River because, unlike the Middle River where the project could alter streamflow and temperature in mainstem spawning habitats, the project would not affect flow or temperature in tributary spawning sites upstream of the inundation zone of the reservoir.

Discussion and Staff Recommendation

All available information suggests that Chinook salmon abundance in the Upper River is generally low. Requiring AEA to develop a dedicated ELH sampling program for Chinook salmon would require a substantial effort because AEA would need to identify and access a reasonable sample size of the very limited Upper River Chinook salmon spawning redds, monitor incubation and inter-gravel temperatures within the redds, and sample for emergence timing. Because the incubation and emergence period spans the winter under ice-cover conditions, some of the work would need to be implemented during the winter when sampling is difficult if not impossible, especially in an extremely remote environment such as the Upper River. Because of these logistical challenges, it is likely that the level of effort needed to complete such a study would significantly increase the cost of the study by up to an additional $1,000,000 (section 5.9(b)(7)) and it is unclear why this additional ELH program is needed because the project would not affect emergence timing of Chinook salmon in reservoir tributaries upstream of the inundation zone (section 5.9(b)(5)).

We anticipate that AEA's proposal to implement bi-weekly, directed juvenile Chinook sampling during spring following ice-out, monthly sampling in the summer and fall, and downstream migrant trapping will be sufficient to describe the locations of juvenile Chinook collections, habitat associations, and fish sizes. This information, coupled with a general understanding of water temperature conditions during the incubation period, can be used to make inferences about emergence timing and life history of Upper River juvenile Chinook salmon (section 5.9(b)(4)). Therefore, we do not recommend requiring AEA to modify the study plan to include developing and implementing an additional ELH sampling program.

Fish Distribution and Abundance Method Modifications

Requested Study Modifications

NMFS recommends the following modifications to the FDA sampling methods: (1) when sampling main and side channels with boat electroshocking, use baited minnow traps and backpack electroshocking along the adjacent bank to capture juvenile salmon; (2) sample with 20 baited minnow traps fished for 20 to 24 hours within every 200-meter sample unit in all habitat types; and (3) weigh the first 100 of each species on each sampling date at each sampling location to the nearest 0.1 gram.

Comments on Requested Study Modifications

AEA disagrees with NMFS's recommended modifications to its methods for selecting sampling gear types and installing baited minnow traps in all habitat types. AEA states that it selected its sample gear type for each sample site according to its approved gear-selection protocol. AEA asserts that minnow trapping is only appropriate in certain habitats such as shallow, slow-water runs or pools, and using minnow traps in all habitats would not be effective because the effectiveness of the traps would vary from highly effective to virtually non-effective with changes in flow, depth, and fish species/life stage composition of the habitat. AEA also indicates that it did subsample along main channel and side channel shorelines in many instances in concert with other sampling techniques such as boat electrofishing, if it made sense to do so according to its gear-type selection protocol. AEA states that it used an average of about three different gear types at each sample site.

AEA states that it is measuring the length and weight of a representative subsample of 25 individuals per species, life stage, and gear type and that this is a sufficient level of subsampling that reduces excessive holding time and stress and is practical when large numbers of juvenile fish are collected. AEA states that it weighed small fish up to 200 grams to the nearest 0.1 gram using digital scales and to the nearest 1 gram for larger fish using spring scales. Lengths and weights were collected from 5,084 fish in 2013 and 5,912 fish in 2014, which represented approximately 72 percent and 76 percent, respectively, of the fish handled in each study year. AEA states that the subsampling approach provides sufficient and representative documentation of fish size, consistent with generally accepted scientific practices.

Discussion and Staff Recommendation

The approved study plan already requires using baited minnow traps and backpack electroshocking within various sampling units where appropriate based on AEA's gear-type selection protocol. However, it does not specifically require AEA to use these methods in concert with boat electrofishing in every main channel or side channel sampling unit, nor does it require AEA to use baited minnow traps for sampling all habitat types. While increasing the sampling effort to include these additional methods may provide some additional data on fish using near-shore areas in some habitat types, it would also likely be an ineffective method for sampling many habitat types such as deep or swift main-channel and side-channel habitats. In addition, we estimate that such an effort could substantially increase the costs of the sampling program (section 5.9(b)(7)) because, in addition to boat electrofishing or whatever other sampling techniques AEA chooses for each habitat type according to its gear-selection protocol, AEA would need to expend significant additional effort sampling 200 meter lengths of shoreline with either backpack electroshockers or by deploying baited minnow traps. In addition, serious logistical issues would be associated with transporting enough minnow traps into the study area to complete NMFS's requested study modification because all traps would

need to be transported via helicopters and loaded on to rafts along with the remainder of the sampling gear and equipment for each sampling crew.

During the 2013 and 2014 study seasons, AEA collected or observed 9 different fish species and nearly 22,000 individual fish in the Upper River, indicating that its sampling program and gear selection protocol are effective, and that it is on track to meet the study objectives (section 5.9(b)(1)) and provide sufficient information to inform our analysis (section 5.9(b)(4)). Therefore, we do not recommend requiring AEA to modify the study plan to include additional minnow trapping or backpack electrofishing.

Further, AEA has been measuring the length and weight of a representative subsample of 25 individuals per species, life stage, and gear type, and we see no reason to expand this level of subsampling to up to 100 fish per sampling event. As noted by AEA, weighing and measuring a subsample of fish is a standard practice in fisheries science, and AEA's proposed approach has provided lengths and weights for more than 70 percent of the fish handled in each study year. This level of effort is more than sufficient to capture a reasonable range of lengths and weights of the fish assemblage in the study area and is consistent with accepted practices for subsampling a population (section 5.9(b)(6)). Therefore, we do not recommend requiring AEA to modify the study plan to include weighing 100 fish of each species on each sampling date at each sampling location to the nearest 0.1 gram.

Sample Site Selection Methodology

Requested Study Modifications

NMFS states that the sample site selection methodology reported in the SIR was incomplete and inconsistent with the approved study plan. NMFS asserts that AEA did not sample all transects as proposed within the FDA Implementation Plan, and that the sampling approach did not provide adequate replication of macrohabitats in the 2013 or 2014 sampling seasons. NMFS contends that the SIR indicates that six side sloughs and six upland sloughs were sampled; however, AEA actually only sampled four upland sloughs, with two sampling units each in two sloughs. Therefore, NMFS recommends that AEA implement the sample site selection methodology that NMFS recommended in its comments on the proposed and revised study plans.

Comments on Requested Study Modifications

AEA states that logistical constraints and dewatered sampling units resulted in fewer units being sampled in 2013. After reviewing the 2013 sampling effort and results, AEA agrees that the number of side channel and off-channel macrohabitats are too low using the transect-based method described in the FDA Implementation Plan. Accordingly, AEA proposed a modification to the approved study plan to address this issue in ISR, part C, section 7.1.2.5, and in the *Proposed 2015 Modifications to Fish Distributions and Abundance Study Plan Implementation Technical Memorandum* filed

on September 26, 2014. AEA's proposed modification includes expanded sampling of off-channel habitats to ensure that better coverage would be achieved in the second year of study, which it implemented in the Upper River in 2014 as a pilot test. AEA states that the revised sampling protocol includes sampling at 35 macrohabitat locations, including 6 or more replicates of upland sloughs, tributary mouths, clear water plumes, side channels, and side sloughs. However, the number of backwater habitats available to achieve six replicate samples in the Upper River were insufficient, and the three that were available were ephemeral. AEA states that it will implement its proposed modified sample site selection protocol during the next study season, which will increase the number of macrohabitat replicates and will allow it to fulfill the study objectives.

Discussion and Staff Recommendation

AEA attempted to complete its sampling in 2013, as required by the approved study plan, but was unable to achieve adequate sampling of some macrohabitats primarily because of logistical issues or dewatered sample units at transect locations. AEA acknowledges these sampling deficiencies and proposes modifications that should significantly increase the level of sampling within the previously inadequately sampled macrohabitats. We agree with AEA that its proposed modifications will likely increase sample replication of macrohabitats and should be sufficient to enable it to better meet the study objectives (section 5.9(b)(1)). Therefore, we do not recommend any additional modifications to the study plan beyond what AEA proposes.

Screw Trap Placement

Requested Study Modifications

NMFS recommends that AEA modify rotary screw trap placement as follows: (1) install and operate a downstream migrant screw trap at the proposed dam site and at the upstream end of the reservoir inundation zone for a minimum of an additional two years during the open water seasons; (2) move the rotary screw traps initially placed in the Oshetna River and Kosina Creek to mainstem locations to better assess movement of downstream migrants; and (3) assess the migration of juvenile Chinook salmon from Oshetna River and Kosina Creek into the Susitna River by expanding the sampling from a frequency of about every other month to a monthly interval and use differences in the relative abundance of juvenile salmonids in tributaries over time to determine movement patterns.

FWS asserts that Upper River rotary screw traps were marginally successful in accurately describing downstream migration of some fish species and unsuccessful for other species. FWS indicates that the generally small number of fish caught in Upper River screw traps (especially Chinook salmon, which averaged fewer than 10 fish per trap over the entire season) indicate that the sampling was unsuccessful. Therefore, FWS

recommends that AEA continue and expand downstream migrant trap operations for two more years.

Comments on Requested Study Modifications

AEA states that it operated a downstream migrant trap on the mainstem Susitna River upstream of the dam site at PRM 200 in 2014 because that was the most suitable location available for trap operation; AEA proposes to operate the trap at the same location during the next study season.

AEA states that it expects that traps placed on the mainstem, downstream of known natal tributary streams, would be less efficient at collecting juvenile Chinook salmon than tributary traps. AEA also indicates that NMFS has not demonstrated how traps in the large mainstem Susitna River would be expected to perform better than traps placed in the tributaries, and that NMFS has not demonstrated how sampling once a month using differences in the relative abundance of juvenile salmonids in tributaries over time would better evaluate fish movement.

AEA disagrees that the Upper River traps have been unsuccessful in documenting movements of fish out of tributaries and within the mainstem based on capture numbers of Chinook salmon, given the catch of that species was rare in the Upper River. AEA states that downstream trapping captured a total of 40 individual juvenile Chinook, accounting for 13 percent of the total juvenile Chinook catch in the Upper River in 2013–2014. AEA also states that for species that are more common in the Upper River, as evidenced by FDA sampling, trap catch was greater, and patterns of movement were discernable, indicating that the techniques were effective in meeting the objective. For example, 1,498 arctic grayling and 699 longnose sucker were collected during downstream migrant trapping in 2013–2014. AEA indicates that trapping is effective, but that the low juvenile Chinook captures are indicative of the low Chinook salmon abundance in the Upper River in general. AEA states that this is supported by the few locations where juvenile salmon have been found during field sampling in 2012, 2013, and 2014 as well as the preliminary findings of the *Genetics Study* (9.14), that indicates the divergence evident in Upper River Chinook salmon is consistent with representation by only a few family groups.

Discussion and Staff Recommendation

AEA installed a downstream migrant trap near the proposed dam site (at PRM 200 in 2014), as required by the approved study plan, but did not install the trap at the exact location specified in the approved study plan because of poor sampling conditions at the dam site. Therefore, it installed the trap at the closest suitable sampling site, located about 16 miles upstream of the dam site. The site provided an effective location to capture outmigrating fish, as evidenced by the number of fish (i.e., 497) and fish species (i.e., 7) captured, including the highest number of juvenile Chinook salmon (i.e., 15) captured in all of the Upper River downstream migrant traps (i.e., Oshetna River and

Kosina Creek). AEA completed one year of downstream migrant trapping at PRM 200 in 2014 and plans to operate a rotary screw trap at that location for an additional year during the next study season. Because the mainstem screw trap site was located between the known Chinook salmon-producing tributaries and because the dam site was successful at capturing a variety of fish species including juvenile Chinook salmon and is not suitable for installing and operating a screw trap, we find that AEA's proposed screw trap location is reasonable and should be adequate to meet the study objectives (section 5.9(b)(1)). Therefore, we see no reason to require AEA to move the screw trap downstream closer to the dam site and operate it for two more years.

Additionally, we see no reason to require AEA to install an additional screw trap in the mainstem upstream of the reservoir inundation zone. As noted above, all available information suggests that Chinook salmon abundance in the Upper River is generally low and those Chinook that are present have a limited and patchy distribution—primarily within the Oshetna River system and Kosina Creek. With the exception of one radio-tagged adult Chinook that migrated into the mainstem upstream of the Oshetna confluence, all the information in the project record shows that Chinook salmon are not spawning or rearing in substantial numbers in the mainstem or tributaries above the reservoir inundation zone (section 5.9(b)(4)). Therefore, we do not recommend requiring AEA to install and operate an additional downstream migrant trap at a cost of at least $300,000 per year (section 5.9(b)(7)) in the mainstem upstream of the reservoir inundation zone for two more years.

We also see no reason to require AEA to move the rotary screw traps previously installed in the Oshetna River and Kosina Creek down to the mainstem. Under AEA's proposed sampling approach, the screw trap previously allocated to Kosina Creek would be replaced with fyke nets at that location and the screw trap would be moved downstream to the mainstem at PRM 200, while the Oshetna River screw trap would continue to be operated within the Oshetna River. This approach is both consistent with the approved study plan and should continue to provide good sampling results that are sufficient to meet the study objectives (section 5.9(b)(1)), because all of these sites have been successful at capturing juvenile Chinook salmon. Moving the traps as recommended by NMFS to previously unsampled sites that may or may not be suitable for screw trap operation would not likely improve the existing data set and could render an entire year of sampling useless if no suitable sites for effective sampling are found.

We also do not recommend requiring AEA to increase its tributary sampling to a monthly interval within the Oshetna River and Kosina Creek to attempt to assess the migration of juvenile Chinook from these tributaries into the Susitna River by comparing the differences in the relative abundance of juvenile salmonids over time. We estimate that the cost of increasing the sampling to a monthly interval would be at least $100,000. Available information suggests that Chinook salmon abundance in the Upper River is generally low and AEA's FDA sampling is sufficiently documenting and characterizing Chinook salmon abundance and distribution in the Upper River (section 5.9(b)(4)). Because Chinook salmon abundance in the Upper River is low, increasing the sampling

interval (i.e., increasing the sampling effort and cost) would not necessarily improve the existing data set or result in a different outcome (section 5.9(b)(7)) . Rather, the most likely outcome would be that the catch per unit of effort would remain the same, such that there would be no improvement to the dataset.

Further, we do not recommend requiring AEA to continue screw trap operations for two more years and then evaluate the ability of these traps to describe the timing of fish migrating past these sites. AEA has already operated screw traps in the Upper River for two study seasons (i.e., 2013 and 2014) and has modified its trapping operations to improve the efficiency of sampling and the sampling results. As noted previously, this has included moving the Kosina trap downstream to the mainstem closer to the dam site and installing a fyke net in Kosina Creek, which has proven more effective at capturing juvenile Chinook at that location than the screw trap. In addition, AEA is proposing to continue its downstream migrant trapping operations for another season to enhance the existing data set, and we anticipate that the information it has already collected coupled with the information it will obtain during the next study season will be sufficient to meet the study objectives (section 5.9(b)(1)) and inform our analysis (section 5.9(b)(4)).

Pit Tagging Modifications

Requested Study Modifications

FWS recommends that AEA consult with the agencies on the effectiveness and value of the PIT tagging program and implement unspecified methods to either improve or expand the existing program or abandon the program and redirect tagging resources to other sampling activities.

Comments on Requested Study Modifications

AEA does not agree with the recommended modification because it states that any additional planning efforts would require additional funds and could potentially expand the PIT tagging program by an unknown amount. AEA contends that the PIT tagging program should continue because it provides very precise information on fish movements at a reasonable cost. AEA also proposes to improve the program during the next study season by moving the existing PIT antenna locations to new locations in smaller waterbodies where the antennas would have better channel coverage and detections, such as Tsisi, Goose or Jay Creeks or higher up in Kosina Creek above the confluence with Tsisi Creek.

Discussion and Staff Recommendation

Although the PIT tag detection results to date have generally been limited, we agree with AEA that there is high value in the information that the PIT tagging program provides and find that the results would likely improve in the future with AEA's proposal to modify the PIT tag antenna locations to improve detection efficiency. However,

selecting the new antenna sites and tagging locations is key to understanding movement patterns and improving detection efficiency; therefore, we recommend that AEA to consult with the agencies on the new antenna locations prior to selecting them. This would be a low-cost (section 5.9(b)(7)) consultation requirement that could improve the efficiency of the program by enabling the agencies to contribute their expertise to the site selection process. Therefore, although we do not recommend expanding or eliminating the PIT-tagging program, we do recommend requiring AEA to consult with Alaska DFG, NMFS, and FWS prior to selecting its new PIT-tag antenna locations.

Radio Telemetry Modifications

Requested Study Modifications

FWS recommends continuing the planning and implementation of radio-tagging studies and evaluating results from the prior years of tagging to assess if tagging goals are achieving the study objectives. FWS also recommends conducting additional targeted searches to identify specific holding or spawning locations.

Comments on Requested Study Modifications

AEA disagrees with the requested modification. AEA states that it completed its radio tagging study and prepared a detailed draft analysis for each target species in the document entitled, *2013–2015 Radiotelemetry Implementation Report*, included as appendix 8 of the 2016 *Filing of Response to Comments on Initial Study Report*. AEA states that this document summarizes tagging and tracking histories for each individual tagged and provides an analysis of seasonal movements, habitat use, and use of the reservoir inundation zone. The locations of tagged individuals during each season (foraging, overwintering, and spawning) are depicted on maps and summarized. AEA states that the report also includes a short discussion comparing the 2013–2015 observations with relevant literature and on tagging goals.

AEA asserts that repeating the study would require two years at approximately $900,000 annually, for a total cost of $1,800,000.

Discussion and Staff Recommendation

Although AEA did not meet tagging goals or study objectives for some species such as Dolly Varden and rainbow trout, this was predominately because fish sizes were either too small for effective tagging or these species were too low in abundance in the Upper River to meet tagging goals. The only way to potentially overcome these obstacles would be to use smaller radio tags and/or significantly increase the tagging efforts, which would significantly increase the study costs and still may not result in additional useful information because of continued low overall abundance of some fish species in the study area. Although the radio tagging study results provide only limited information on fish behavior and spawning locations for some species, the available

results coupled with AEA's other study efforts such as downstream migrant trapping and FDA sampling should collectively provide the information necessary to describe the existing environment and inform our analysis of project effects on the resident fish community of the Upper River (section 5.9(b)(4)). Therefore, we do not recommend any modifications to the study plan.

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

Background

The study focuses on describing the current fish assemblage, including spatial and temporal distribution and relative abundance by species and life stage in the Susitna River downstream of the proposed Watana Dam site (PRM 184), with an emphasis on ELH of salmonids and seasonal movements of selected species.

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

Study objectives include the following: (1) describing 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) describing seasonal movements of juvenile salmonids and selected fish species such as rainbow trout, Dolly Varden, humpback whitefish, round whitefish, northern pike, Arctic lamprey, Arctic grayling, and burbot, with emphasis on identifying foraging, spawning, and overwintering habitats in the mainstem of the Susitna River, including: (a) documenting the timing of downstream movement and catch using out-migrant traps; and (b) describing seasonal movements using biotelemetry PIT and radio-tags); (3) Describing ELH, timing, and movements of anadromous salmonids, including: (a) describing emergence timing of salmonids; (b) determining movement patterns and timing of juvenile salmonids from spawning to rearing habitats; and (c) determining juvenile salmonid diurnal behavior by season; (4) collecting baseline data to support the stranding and trapping study (i.e., part of study 8.5); (5) documenting winter movements and timing and location of spawning for burbot, humpback whitefish, and round whitefish; (6) documenting the seasonal age class structure, growth, and condition of juvenile anadromous and resident fish by habitat type; (7) documenting the seasonal distribution, relative abundance, and habitat associations of invasive species (northern pike); and (8) collecting tissue samples from juvenile salmon and opportunistically from all resident and non-salmon anadromous fish to support study 9.14.

In addition to the study description provided in the study plan, AEA also prepared a FDA Implementation Plan that provides additional information on the sampling strategy, study site selection process, and field sampling procedures. Specifically, the Implementation Plan requires: (1) a summary of relevant fisheries studies in the Susitna River; (2) an overview of the life-history needs for fish species known to occur in the Susitna River; (3) a review of the preliminary results of the 2012 habitat characterization and mapping efforts; (4) a description of site selection and sampling protocols; (5) details regarding development of field data collection forms; and (6) details regarding development of database templates that comply with 2012 AEA quality assurance/quality control procedures.

AEA initiated a pilot study effort in 2012, prior to the study plan determination, to assist in study methodology development. The pilot effort did not include all methods, nor did it occur at all sites that were subsequently included in the approved study plan, and as such, did not represent a complete sampling year. AEA completed one year of sampling between 2013 and 2014 and reported the results in November 2015. Although AEA conducted two years of studies for some study components such as ELH sampling in the Middle River, not all study objectives were met; AEA plans to complete a second year of sampling prior to the USR.

As required by the approved the study plan, AEA's sampling strategy differed by season (spring versus summer) and river segment (middle versus lower river). To date, AEA has generally sampled as required by the approved study plan according to the schedule and strategy described in table 1.

Table 1. Middle and Lower River sampling strategy implemented to date.

Season	**Middle River Sampling**	**Lower River Sampling**
Winter	Sampling at three replicates of randomly selected macrohabitats within each of three Focus Areas during February through April, with additional non-random opportunistic sampling in nearby habitats of interest.	None.
Spring	Bi-weekly non-random ELH sampling at six select sites that are near known spawning and rearing locations within each of six Middle River Focus Areas between ice-out and July 1.	Bi-weekly non-random ELH sampling at select sites between ice-out and July 1.

Season	Middle River Sampling	Lower River Sampling
Summer/Fall	Randomly selected GRTS sites at about 180 sample locations, sampled 3 different times during open-water season (twice during the summer and once in the fall) between the dam site (PRM 187.1) and three rivers confluence area (PRM 102.4).	Transect-based approach whereby sampling occurred along 10-transects equally spaced at 7.4-mile intervals between the three rivers confluence area (PRM 102.4) and the Yentna River confluence (PRM 32.3). Sampling occurred three different times during open-water season (twice during the summer and once in the fall).

Based on AEA's review of its study methods implemented to date and comments received on the ISR, AEA proposes to generally continue its sampling strategy described in table 1 during the next study season. However, in the Lower River, it proposes to modify its sampling strategy to include additional sampling of rare off-channel habitats. This modified sampling strategy would include continuing the transect-based approach for selecting the abundant main-channel habitat units, but implementing a GRTS sampling approach for selecting rare off-channel habitat types such as upland sloughs, side sloughs, and tributaries to increase replication of these less abundant macrohabitats that were under-sampled in 2013.

Several of the comments and requested study modifications for study 9.6 are identical to those submitted for study 9.5. We do not address redundant comments herein because our analysis and recommendations apply to both studies.

Spring Sampling

Requested Study Modifications

NMFS states that spring sampling (May and June) was not conducted as required by the approved study plan because AEA did not conduct spring sampling at all FDA sample sites; therefore, it recommends that AEA "expand" the spring sampling to include sampling at all FDA sites.

Comments on Requested Study Modifications

AEA states that spring studies were implemented as approved, and that NMFS has not provided any additional or new information that indicates why the approved study is not sufficient.

Discussion and Staff Recommendation

It is unclear why NMFS contends that spring sampling was not conducted as required by the approved study plan. Section 9.6.4.3.3 of RSP and section 5.5 of the FDA Implementation Plan both state that the spring early life-history sampling will occur bi-weekly following ice break-up through July 1 in specific non-randomly selected sample sites within Middle River Focus Areas to characterize salmon early life histories and outmigration behavior. The spring sampling as specified in the approved study plan was not intended to occur at all of the approximately 180 randomly selected Middle River FDA sampling sites. Rather, only the summer and fall sampling events were to occur at all of these randomly selected FDA sample sites. Expanding the spring sampling program to all FDA sample sites would not likely be very effective because of the challenging sampling conditions that occur in the spring during breakup (e.g., very high flows and turbidity). Moreover, the summer and fall sampling at 180 randomly selected FDA sites (see table 4.1-3 of study 9.6 SIR) as required by the approved study plan is already providing sufficient information on general FDA throughout the study area; therefore, it is unclear why an additional spring sampling event at all 180 summer and fall sample sites is needed (section 5.9(b)(4)).

AEA's proposal to continue to sample a select number of non-random study sites during the spring to capture salmon ELH and outmigration behavior is consistent with the approved study plan and should be sufficient to meet the study objective (section 5.9(b)(1)). Therefore, we do not recommend requiring AEA to expand the spring sampling to include additional sampling at all 180 Middle River summer and fall FDA sample sites.

Winter Studies

Requested Study Modifications

NMFS recommends that AEA document the Middle and Lower River fish distribution, habitat association, and abundance during the winter months by expanding the winter sampling to include all Focus Area GRTS sampling locations selected for spring, summer, and fall sampling.

NMFS contends that pilot studies conducted in the winter of 2012–2013 demonstrated that winter sampling is feasible, and AEA did not complete monthly sampling within Focus Areas as required by the approved study plan. Winter sampling conducted in 2013–2014 was limited in scale and only conducted within a few Focus Areas with little replication of macrohabitats. NMFS asserts that winter sampling must occur from December after stable ice has formed and be completed by March before juvenile fish migration starts. Sampling conducted in April should not be considered winter sampling because fish have already begun to respond to longer periods of daylight and other seasonal conditions.

FWS recommends that AEA develop an operational plan for winter sampling that increases the geographic range and diversity of habitats sampled and includes measuring physical attributes of the sites.

Comments on Requested Study Modifications

AEA states that the 2012–2013 winter pilot study in the Whiskers Slough Focus Area was conducted to determine logistics and safe and suitable methods and make recommendations for future winter sampling efforts. Based on the pilot study, AEA determined that winter studies pose significant risks and hazards to field crews and concluded that a collaborative study approach among resource disciplines concentrated in a handful of well-studied Focus Areas with good accessibility was needed for a safe and successful sampling effort. AEA indicates that its pilot study determined that winter ice conditions were extremely dynamic and finding flowing water under the ice in the main and side channels was challenging, except for open water leads, which were avoided to minimize risks to field crews. Applying the concepts learned from the pilot study, AEA concentrated winter study efforts in 2013–2014 at a subset of established Focus Areas with good accessibility (FA-104 [Whiskers Slough], FA-128 [Slough 8A], and FA-138 [Gold Creek]). AEA conducted monthly sampling with the timing dependent on safe and practical transportation and ice conditions. Sampling was implemented at the same stratified macrohabitat locations that were randomly selected using the GRTS method during the 2013 open-water FDA sampling. AEA intends to conduct another year of winter studies at these same sites.

AEA argues that April is still considered winter on the Susitna River because the river is completely frozen over and the mainstem temperatures remain less than 0–1°C. AEA also indicates that April is a very interesting and critical part of winter to study because the photoperiod and productivity increase and large number of salmon fry begin to emerge.

Discussion and Staff Recommendation

As noted by AEA, winter sampling is difficult and dangerous, and AEA's winter sampling program is incomplete and ongoing. Therefore, it would be premature at this time to conclude that AEA's proposed winter sampling (i.e., monthly sampling [weather and field conditions permitting] of three replicates of each macrohabitat in each of three Focus Areas using randomly selected sample sites) is insufficient to meet the study objectives (section 5.9(b)(1)).

Additionally, expanding the winter sampling effort to include monthly sampling at all Focus Area FDA GRTS sample sites would incur significant additional costs, likely exceeding $1,000,000 (section 5.9(b)7)), and could pose substantial safety risks. It is unknown how many of these sites would be safe to access at all, let alone multiple times over the course of the winter to sample at NMFS's recommended monthly interval.

Therefore, we find AEA's proposed winter sampling strikes a reasonable balance between safety and feasibility and should be sufficient to meet the study objectives (section 5.9(b)(1)) and inform our analysis (section 5.9(b)(4)). We also agree with AEA that April sampling is representative of winter conditions given that the river is frozen over and water temperatures are 0–1°C, regardless of whether the days are longer than those earlier in the winter. Therefore, at this time we do not recommend requiring AEA to modify or expand its winter sampling beyond what it already proposes to implement during the next study season.

Macrohabitat Sampling

Requested Study Modifications

NMFS contends that AEA did not sample as required by the approved study plan because, among other reasons, it did not classify macrohabitats using the approved habitat classes that were verified in the field prior to additional site selection or field sampling. NMFS contends that macrohabitats should include only those specified in the study plan determination: main channel, side channel, split channel, multiple split channel, tributary mouth, side slough, and upland slough. NMFS asserts that sampling locations in the Middle River did not include entire tributary mouths or the mouths of side sloughs and upland sloughs as defined in the study plan determination (i.e., AEA did not initiate slough sampling at the mouths of all sloughs). NMFS states that some field sampling, data analyses, and reporting within the ISR were conducted at the mesohabitat (Level 4) and this deviation from the approved study plan does not comply with generally accepted scientific practices because AEA should have implemented all sampling within Level 3 macrohabitats.

Comments on Requested Study Modifications

AEA states that it is unclear why this study modification is needed because it used macrohabitat classifications to select FDA sampling sites in accordance with the approved study plan. AEA states that limiting sampling units to Level 3 macrohabitat types within its hierarchical classification system would eliminate sampling of clear water plumes and backwaters, which were classified as Level 4 mesohabitats. Such an approach would be in clear contradiction to previous requests, other comments on the ISR, and the study plan determination requirement to give these habitats special consideration when sampling. AEA indicates that it sampled all macrohabitat types listed by NMFS along with tributary habitat, clear water plumes, and backwaters, and that the data from these habitat units can be combined for analysis purposes into any desired tributary mouth definition.

AEA indicates that it did not follow the Commission's recommendation in the study plan determination to initiate all slough sampling at the confluence with the mainstem Susitna River and continue 200 meters upstream because it was inconsistent

with its GRTS methodology for random site selection that provides for an unbiased sampling design that is spatially balanced across the landscape. AEA argues that if all sample sites were selected to begin at the confluence with the mainstem and continue upstream 200 meters (as required by the study plan determination), results would be biased toward the species and life stages using these areas and would not be representative of the species and life stages using other areas of the slough. Therefore, as a compromise with agency desires to gather additional information in these areas and to attempt to meet the intent of the study plan determination, AEA inspected slough confluence areas for mainstem backwatering and sampled these areas when slough habitats were sampled, while still sampling other areas of the slough selected by the GRTS program.

AEA asserts that sampling under the GRTS program adequately sampled the downstream end of sloughs while preserving the random study design for the best characterization of overall fish use of upland slough and side slough features. In total, 26 Middle River slough mouth locations were sampled in 2013–2014; 10 were in backwater areas, 9 were at the downstream end of side sloughs, and 7 were at the downstream end of upland sloughs.

Discussion and Staff Recommendation

It is unclear why NMFS asserts that AEA's classification and sampling scheme were inconsistent with the methods in the approved study plan and were not implemented using accepted practices. NMFS appears to base this conclusion on a variety of issues, including that AEA characterized some backwaters as main channel mesohabitats within Level 4 of its channel classification system, while it classified other backwaters as Level 3 slough habitats. However, AEA appears to have made its decision on which backwater habitats belonged in each habitat type using informed decisions that were based on site-specific field observations at the time of sampling, which is a reasonable and accepted practice (section 5.9(b)(6)). Moreover, most of the disagreements between AEA and NMFS over how habitats should be classified appear to be based on differences of opinion and interpretation of the habitat classification maps or aerial videography generated under study 9.9 when compared to AEA's observations in the field at the time of sampling. Given the size (i.e., about 184 river miles) and complexity of the study area, however, it is reasonable to expect that there will always be some level of disagreement between experts of how habitat units should be classified. As discussed further in study 9.9, based on our review of the habitat maps and the study reports, we do not have good cause to find that AEA's methods for classifying and sampling these habitats in the field were incorrect and should be done differently.

With respect to sampling backwater habitats at slough mouths, AEA did not initiate sampling at the downstream end of all sloughs beginning at the backwater and continuing upstream for 200 meters as required by the approved study plan. However, AEA did sample 26 of 66 Middle River slough mouths (classified as either Level 4

mainstem mesohabitats or as Level 3 slough macrohabitats). This is a sufficient sample size to meet the intent of the study plan determination requirement that AEA identify and give specific consideration to these backwater habitats. In addition, as indicated by AEA, the results from these backwater sampling units could be combined or reassigned to a different habitat unit for analysis purposes in the future, if desired. For these reasons, we conclude that AEA implemented the study plan in a manner that should enable it to meet the study objectives (section 5.9(b)(1)); therefore, we do not recommend any modifications to the study plan.

Lower River Sampling

Requested Study Modifications

NMFS recommends expanding AEA's proposed Lower River FDA sampling by selecting sampling units based on macrohabitat classification for determining fish habitat associations. NMFS contends that preliminary study results suggest that the Lower River segment supports rearing and overwintering juvenile salmonids and that preliminary modeling results suggests that project effects will extend into the Lower River. Therefore, NMFS recommends modifying the study to include classifying and sampling macrohabitats in a minimum of 10 tributary mouths, side sloughs, upland sloughs, side channels, and main channel habitats in the Lower River.

Comments on Requested Study Modifications

AEA asserts that NMFS's modification request is redundant to their prior study request and comments on the RSP that were already considered in the April 1, 2013, study plan determination. AEA states that FDA sampling in the Lower River in 2013 was based on systematic random sampling of macrohabitat types in proximity to selected transect locations, as required by the approved study plan. AEA acknowledges that the methods implemented in 2013 resulted in an insufficient number of sample units of rare habitats because they were not located close to the transect locations. In light of this deficiency and because AEA's updated open-water flow routing model suggests there will be stage changes in the Lower River upstream of the Yentna River confluence under project operations, AEA proposes expanding the Lower River sampling of rare habitats using the same hybrid transect and GRTS approach that it proposes for the Upper River in study 9.5. Under this approach, sampling using transects equally spaced every 7.4 miles would continue for the relatively abundant main channel habitat types, while a GRTS sampling approach would be used to select rarer off-channel habitats such as upland sloughs, side sloughs, and tributary mouths. AEA's expanded off-channel habitat sampling would encompass six replicates of each off-channel macrohabitat type, which it notes is consistent with NMFS's prior comments and study requests.

Discussion and Staff Recommendation

AEA attempted to complete its Lower River sampling in 2013 using its systematic transect-based sampling approach as required by the approved study plan. It was unable to achieve sufficient samples of rare macrohabitats, however, primarily because the number of sampling units close to the transects was insufficient. AEA acknowledges these sampling deficiencies and proposes to significantly increase the level of sampling in the previously inadequately sampled macrohabitats. We agree with AEA that its proposed modifications will likely increase sample replication of rare macrohabitats and should be sufficient to enable it to better meet the study objectives (section 5.9(b)(1)). Therefore, we do not recommend any additional modifications to the study plan beyond what AEA proposes.

Emergence and Early Life History Sampling

Requested Study Modifications

NMFS recommends four modifications to the approved plan related to ELH sampling: (1) adopt AEA's proposal to integrate emergence studies with proposed winter sampling at all Focus Areas prior to breakup, suspending sampling during breakup, and reinitiating sampling following breakup; (2) continue bi-weekly sampling until July 1 or until 90 percent of emergent fry are greater than 50-millimeter (mm) fork length; (3) conduct ELH studies on all sampling dates at all Focus Areas, as described in the RSP, and add minnow traps and fyke nets with hoop traps in all sampling locations on all sampling dates; all traps, nets, and hoop traps should contain mesh sizes of 1/8 inch or less; and (4) expand ELH sampling to all FDA sites in the Lower River in addition to the proposed bi-weekly spring ELH sampling at select sites.

FWS recommends two modifications related to ELH sampling: (1) develop a complete and rigorous ELH sampling program that better integrates the inter-gravel monitoring component of the ELH studies and focuses on the location and timing of Chinook salmon emergence, and (2) integrate the ELH sampling with the abundance and distribution sampling program to provide an understanding of the early spring distribution of fish species and life stages.

Comments on Requested Study Modifications

AEA disagrees with the recommended modifications and clarifies that it does not propose to conduct emergence studies or emergence trapping because existing information on embryo development and emergence timing from the 1980s is sufficient. Instead, AEA states that it proposes to conduct monthly sampling in winter (February–April) and bi-weekly sampling for juvenile salmon at selected sampling sites from breakup to July 1 to inform and confirm juvenile salmon emergence timing and provide information on juvenile salmon growth and early life histories. As discussed above, winter sampling was not intended to occur at all Focus Areas; rather, sampling sites were

selected to (1) correspond with inter-gravel temperature monitoring at a subsample of Focus Areas representative of the Middle River, (2) contain known spawning areas and a diversity of habitat types, and (3) occur in areas where work could be conducted safely to minimize risk during the hazardous winter sampling conditions. AEA indicates that this information coupled with the downstream migrant trapping data will be sufficient to characterize emergence timing, early growth, and movements. AEA asserts that designing and implementing an emergence study program at 10 Focus Areas, including monitoring spawning locations at the frequency recommended by NMFS and FWS, would have an estimated cost of between $1,000,000 and $1,200,000 a year.

AEA states that in 2013 and 2014, six Focus Areas were sampled for ELH, which was greater than the five required in the approved study plan. Sampling frequency met the bi-weekly sampling schedule proposed from breakup to July 1 and went beyond the approved schedule to include a pre-breakup sampling event at three Focus Areas in 2013. AEA also states that NMFS mischaracterizes the mesh sizes and openings of seines and minnow traps used for salmon ELH sampling; only fabric minnow traps (0.125-inch nylon mesh) were used for salmon ELH sampling. After reviewing catch data, minnow traps were found to be size- and species-selective, missing the smallest and largest fish present. However, during spring 2013 after the FDA Implementation Plan was prepared, AEA ordered custom-made fyke nets with 0.125-inch mesh specifically for ELH sampling. AEA indicates that the 0.125-inch mesh gear was used for 97 percent of net and trap samples in the Middle/Lower River and 86 percent of all net and trap ELH samples.

AEA disagrees with NMFS's recommendation to expand ELH sampling in the Lower River to all FDA sites for the same reasons that it does not propose expanding the bi-weekly sampling to all FDA sites in the Middle and Upper River (e.g., high flows and turbidity in the mainstem during the spring).

Discussion and Staff Recommendation

At this point, AEA's ELH sampling efforts are incomplete and ongoing. However, during the 2014 sampling events in the Middle River alone, AEA collected more than 18,000 juvenile salmon during bi-weekly sampling[17] at six sites in each of six Focus Areas. This level of sampling effort was consistent with the approved study plan, and the substantial number of salmon collected suggests that the ELH sampling program is successful at collecting ELH data on juvenile salmon. Based on the substantial number of juvenile salmon AEA collected during the ELH sampling program to date and the additional ELH sampling it proposes in both the Middle and Lower River in the next study season, we anticipate that AEA is on track to meet the study objectives (section 5.9(b)(1)) and collect sufficient information on salmon early life histories to inform our

[17] Bi-weekly sampling began on May 4, 2014, following break-up and continued through the end of June.

analysis of project effects on these sensitive life stages (section 5.9(b)(4)). Therefore, we see no reason to expand the ELH sampling program as recommended by the agencies at an additional cost of $1,000,000 to $1,200,000 a year (section 5.9(b)(7)).

Screw Trap Placement and Monitoring

Requested Study Modifications

In their comments on studies 9.5 and 9.6, NMFS and FWS recommend that AEA continue and expand downstream migrant trap operations for two years. NFMFS and FWS also recommend that AEA expand operations to seven days a week, assess the efficiency of traps using a mark-recapture study, begin trap operations earlier in the season, and relocate traps to waters more favorable to trap operations. NMFS specifically recommends that the traps be deployed at the following locations: Indian River, mainstem near Curry, mainstem near Talkeetna Station, and Montana Creek.

Comments on Requested Study Modifications

AEA states that expanding trap operations to seven days a week for two additional years would result in increased overall catch but would not lead to a significantly better understanding of the timing of outmigration and movements and would cost an additional $2,800,000 a year to implement. AEA indicates that these resources would be better spent on open-water studies, including ELH sampling, FDA sampling, and fish tagging and monitoring through biotelemetry. AEA also states that the downstream migrant traps cannot be installed any earlier in the season because it must wait until the ice break-up process is complete to avoid trap damage or loss. Ice break-up in 2013 was concentrated between May 25 and May 29, and ice continued to float down river during the first week of June. AEA proposes to continue to deploy traps as soon as possible after break-up for an additional year

With regard to a mark-recapture study to measure the efficiency of the rotary screw traps, AEA states that the approved study plan already requires trap efficiency estimates to generate relative abundance estimates, but only when catch exceeded 100 fish, and daily catches rarely met that target. AEA states that unfortunately the low daily catches were insufficient for generating meaningful Peterson mark-recapture estimates, even when catches exceeded 100 fish per day. AEA states that in the Middle and Lower River in 2013, efficiency testing was conducted on 11 occasions at Indian River, 10 occasions on Montana Creek, 5 occasions at Talkeetna Station, and 0 occasions at Curry Station. AEA states that the number of fish that were healthy and available for efficiency tests was often fewer than 100 and that the efficiency results should be interpreted with caution. Nevertheless, AEA indicates that regardless of whether it can determine trap efficiency during all trapping events, the trap data show that AEA is making progress towards documenting the downstream movements and timing of resident and juvenile anadromous fish.

To enable it to better meet the study objectives, AEA proposes to relocate the Curry Station trap and the Montana Creek trap to the mainstem Susitna below Portage Creek between PRM 151.3 and 152.3 and to the mainstem Susitna in the vicinity of Montana Creek, respectively. AEA states that these new locations will increase trapping efficiency and catch rates, provide better coverage of fish emigrating from Portage Creek (a major spawning tributary), and increase catch of fish originating upstream of Devils Canyon.

Discussion and Staff Recommendation

We see no reason to require AEA to modify its downstream migrant trap operations as recommended by FWS and NMFS because it is unclear why these changes are needed or how they would better enable AEA to meet the study objectives (section 5.9(b)(1)). Expanding trapping operations to seven days a week for two additional years and attempting to install traps earlier in the season as recommended by FWS and NMFS could be useful if the intent of the trapping was to assess fish population sizes. In that case, consistent estimates of trap efficiency would be required, along with additional sampling to cover a greater percentage of the study area. However, the downstream migrant trapping results were never intended to develop definitive population estimates, and such information is not needed for our analysis. Additionally, we agree with AEA that it is reasonable and appropriate to install the traps as quickly as possible after ice break-up and there is no reason to install them earlier where they would be at a higher risk of damage or loss.

At this point, AEA's migrant trapping is incomplete and ongoing; however, AEA has generally implemented its screw trap operations as required by the approved study plan, and the information it has already collected coupled with the additional data it proposes to collect during the next study season should be sufficient to characterize downstream movements and timing of resident and juvenile anadromous fish (section 5.9(b)(1)). Therefore, we do not recommend any modification to the study plan beyond what AEA proposes.

However, to ensure consistency with the methods specified in the approved study plan, we recommend AEA continue to attempt to conduct efficiency tests following the schedule specified in the FDA Implementation Plan, to the maximum extent possible. The testing results would provide additional information on fish abundance in the study area and augment the results of the seasonal FDA sampling.

Pit Tagging Modifications

Requested Study Modifications

NMFS recommends modifying the study so that the results can be used to determine the movement patterns of juvenile salmon from spawning tributaries to the mainstem and off-channel habitats. NMFS states that the PIT tag studies were largely

ineffective and did not provide information on the proportion of juvenile Chinook or coho salmon from tributary spawning locations that moved to the mainstem for rearing and overwintering. NMFS states that the PIT tag study was not conducted as described in the approved study plan because antenna arrays were not installed in a manner that would allow upstream and downstream migration to be detected, detection efficiency was not estimated, and PIT tag antennas in Indian River and Montana Creek did not cover the entire channel. NMFS recommends expanding the geographic extent of PIT tagging to include Whiskers Creek, Montana Creek, and Indian River during the two summer and single fall FDA sampling events. NMFS contends that a minimum of 500 Chinook, 500 coho, and 500 sockeye should be tagged during each sampling event at each location.

FWS recommends that AEA evaluate the effectiveness and value of the PIT tagging program because thus far the value of the PIT tagging program to describe fish movements is questionable. FWS argues that the PIT antennas were not installed in sequential spatial intervals at antenna sites, which eliminating the ability to both discriminate upstream or downstream movement and assess detection efficiency. FWS argues that very small numbers of tagged fish were captured outside of the areas where they were tagged; therefore, interpreting the results from so few recaptured fish is problematic because the tagging effort is not representative of the various habitat types or behavior characteristics.

FWS contends that a detailed evaluation of the results of PIT tagging activities and discussion among involved researchers may provide insights into ways to (1) improve and expand the existing sampling and tagging program, (2) redirect tagging objectives to more attainable results (e.g., intensive study of a limited section of river), or (3) abandon the PIT tagging program and direct resources to other sampling activities.

Comments on Requested Study Modifications

AEA states that the general locations of PIT tag antennas were chosen to complement areas of intensive fish sampling (e.g., Focus Areas) during the FDA study, maximize the number of PIT tags deployed in the vicinity of each antenna, and increase the subsequent number of detections. AEA indicates that the effectiveness of the PIT tagging program was constrained by channel conditions and receiver time drift but also notes that despite the challenges, the information gathered by PIT antennas in the Middle River is useful. AEA states that a total of 1,192 of 7,525 PIT tagged fish (16 percent) were either redetected or recaptured, providing information on fish movement and growth.

AEA proposes to continue PIT tagging during the next study season by installing PIT antenna arrays at four locations—installing two antennas at the 2013 Whiskers Slough and Slough 8A sites and relocating the other two antennas previously installed at Indian River and Montana Creek to new sites that are closer to fish sampling and tagging locations to improve redetection and recapture rates.

Discussion and Staff Recommendation

It is unclear why NMFS' and FWS's recommended modifications are needed (section 5.9(b)(4)). Although NMFS and FWS assert that the PIT-tagging program is ineffective and that the program should either be eliminated or reevaluated and modified according to their recommendations to improve its effectiveness, we see no reason to require this. The objective of the PIT tagging program is to provide information on seasonal fish movements and fish growth.[18] In the approved study plan, AEA indicates that the PIT-tagging program will rely on relatively few individual fish to provide this information, acknowledging that detection and recapture rates of PIT-tagged fish will be low because of the small detection range of PIT antennas and the large size and complexity of the streams being sampled. To date, AEA detected or recaptured 16 percent of the PIT-tagged fish, which seems like a reasonable rate of detection/recapture given the challenging sampling conditions and should provide some fine-scale information on fish migration and growth to augment the broader-scale movement data collected by the downstream migrant traps and radio telemetry studies. Therefore, although AEA's PIT tagging program is incomplete and ongoing, the preliminary results suggest that it is collecting useful information on fish movements and growth and appears to be on track to meet the study objectives.

However, selecting new PIT antenna sites to replace the Indian River and Montana Creek sites is important to understand movement patterns and improve PIT tag detection efficiency. Consulting with the agencies on the new PIT tag antenna locations prior to selecting them could improve the program by enabling the agencies to contribute their expertise to the site-selection process. We envision that such consultation would be a low-cost measure that could occur during AEA's planned TWG meetings (section 5.9(b)(7)). Therefore, although we do not recommend modifying or eliminating the program as recommended by the agencies, we do recommend requiring AEA to consult with Alaska DFG, NMFS, and FWS prior to selecting the two new PIT-tag antenna locations.

Radio Telemetry Modifications

Requested Study Modifications

FWS requests that AEA continue planning and implementing radio-tagging studies to assess if tagging goals are appropriate for achieving the stated objectives. FWS requests that AEA conduct targeted searches to identify specific holding or spawning locations. FWS states that radio-tagging provided a good description of fish movements for the few fish that did survive; however, FWS asserts that the study is inadequate

[18] Fish growth would be derived by comparing changes in length and weight between initial tagging and recapture during future sampling.

because of the variances. FWS comments that the release of radio-tagged fish was not distributed throughout the Susitna River drainage and that manual tracking and directed searches to identify habitats for spawning or holding fish was not conducted.

NMFS recommends additional radio tagging efforts that include: (1) distributing tagged fish equally among geomorphic reaches or proportional to the relative abundance of each target fish species; (2) conducting aerial over-flights to contrast with boat, foot, or snow machine tracking as described in the RSP; (3) capturing additional fish during winter surveys; and (4) determining the status of recaptured fish.

NMFS asserts that the radio tag study objectives were not met because resident fish spawning, foraging, and overwintering locations and characteristics were not identified. NMFS argues that the distribution of radio tags released throughout the drainage was not uniform, and that uniform distribution would provide a more detailed assessment of migration from and into different river areas. NMFS also comments that 2013 tagging goals were not met for Dolly Varden, burbot, artic grayling, longnose sucker, humpback whitefish, round whitefish, and northern pike. NMFS states that winter biotelemetry observations were mostly limited to monthly aerial surveys for radio tags, and little winter data were likely collected between aerial surveys because the fixed receivers at Whiskers Creek, Indian River, Devils Island, and Kosina Creek are only operational above -4°F.

Comments on Requested Study Modifications

AEA states that resident fish foraging, overwintering, and spawning locations are described in the *2013–2015 Radiotelemetry Implementation Report*. AEA agrees that not all tagging goals were met in year one in the Middle River, which is one reason why additional tagging will occur in the next year of study. Section 5.8 of the FDA Implementation Plan clearly describes the tradeoffs between tag size, pulse frequency, and battery life. The operating life of tags ranged from 180–901 days depending on the size of the fish tagged. AEA does not propose to collect two years of data for each tagged individual. In several instances, radio-tagging was done opportunistically when large fish were collected at fishwheels, at downstream migrant traps, or by FDA study crews sampling tributary mouths and clear water plumes. AEA contends that the approved study plan describes the allocation of tags between the upper and middle and lower river segments but does not specify that tags will be equally distributed between geomorphic reaches. Although a concerted effort was made to distribute tags around the study area, resident fish of taggable size were not commonly collected everywhere, and tagging occurred where these fish were most abundant. In addition, AEA crews implemented directed efforts to increase tag numbers for species that were rare in collections. AEA states that while there were very high catches for some species during fish sampling efforts, very few of these individuals were of taggable size. AEA states that some species had sufficient numbers of tagged fish surviving into the spawning season to provide good documentation of spawning sites and behaviors while others did

not. AEA also argues that, while the approved study plan requires it to implant radio tags in fish just prior to spawning, it is not a generally acceptable scientific practice to surgically implant radio tags in fish in the pre-spawning phase when they are more energetically taxed (as a result of limited food availability during the winter months) and potentially more sensitive to the stresses associated with handling. Therefore, AEA documented the timing of tagging as a variance in the ISR and SIR and provided its rationale for why the variance was warranted.

Discussion and Staff Recommendation

As indicated by AEA, the radio tagging component of this study is incomplete and ongoing, and AEA proposes another year of data collection during the next study season to attempt to achieve its tagging goals for target fish species. Therefore, while AEA appears to be on track to meet the study objectives, insufficient information is available to definitively determine whether this is the case. For these reasons, it would be premature to require AEA to modify the study plan, and we do not recommend requiring it to do so.

Northern Pike Study Modifications

Requested Study Modifications

NMFS and FWS recommend modifying the approved study plan to require the development of a more complete sampling and radio-tagging program for northern pike. NMFS and FWS argue that sampling was not conducted in locations likely to support northern pike because of transect-based site selection. As a result, an insufficient number of pike were tagged to describe the seasonal distribution, relative abundance, and habitat associations of northern pike. Only five pike were radio tagged, and all of these fish were captured in one general location in the Lower River. NMFS states that northern pike are invasive to the Susitna River and have resulted in the closure of recreational fisheries in Alexander Creek and severely reduced populations of coho, Chinook, and sockeye salmon in other Susitna River tributaries. The proposed project would alter Susitna River flows and could increase the vulnerability of juvenile salmon to pike predation and alter habitats in a manner that would benefit northern pike. The agencies contend that far more effort and resources need to be allocated to this part of the study to meet the study objective, and the sampling plan should identify sampling locations and methods that can target northern pike populations.

Comments on Requested Study Modifications

AEA states that northern pike were tagged in the known range for the species in the Susitna River study area. Tagging occurred during the foraging period and in the section of the river where northern pike are expected to be present. All detections of northern pike during FDA sampling were in the known range for the species in the

Susitna River; thus AEA concludes that sampling and tagging results indicate that northern pike do not occur in the Upper or Middle River. However, because the small number of individuals tagged provides limited information on northern pike distribution and abundance, AEA plans another year of radio tagging and tracking efforts in the study area with the goal of allocating a total of 30 radio tags to northern pike in the Middle and Lower River. AEA indicates that targeted sampling for northern pike may be necessary in the Lower River to reach tagging goals because of the insufficient number of pike captured during FDA sampling.

Discussion and Staff Recommendation

We see no reason to require AEA to modify the study to include an additional or expanded radio tagging or sampling program for northern pike. The approved study plan requires AEA to attempt to tag 30 northern pike through its FDA sampling program in the Middle and Lower River, with the caveat that directed sampling using other means such as angling at known pike locations will be employed if the FDA sampling captures an insufficient number of pike for tagging. Although AEA did not capture many northern pike during its sampling to date, the absence of northern pike in catch data does provide data on the distribution (or lack thereof) of pike. Moreover, AEA intends to attempt to reach its tagging target of 30 pike during the next study season and will use directed sampling at known pike locations if needed. Therefore, AEA is implementing the study as required and should be on track to meet the study objective of documenting the seasonal distribution, relative abundance, and habitat associations of invasive species such as northern pike (section 5.9(b)(1)).

Species Identification Modifications

Requested Study Modifications

NMFS recommends that the Commission require AEA to: (1) identify juvenile salmon to species, (2) measure all juvenile salmon captured in migrant traps that are greater than 45-mm fork length to validate species identification and age class (i.e., age-0, or age 1+); (3) measure all fish captured to fork length as proposed within the RSP and weigh the first 100 of each species on each sampling date at each sampling location to the nearest 0.1 gram, and (4) collect tissue samples from 1 in 10 juvenile salmon (i.e., belly swab with q-tips) for genetic analyses to confirm species identification; and (5) implement pre-season field crew training in juvenile salmon identification.

NMFS contends that fish data should be reported by age class based on size frequency distributions or by fork length rather than age class designations used by AEA. NMFS asserts that the age class designations used by AEA (fry, parr, juvenile, and smolt) are subjective and do not contribute toward meeting study objectives because no clear distinction exists between salmon fry and parr, or parr and juveniles, or juveniles and smolts.

FWS recommends that AEA develop a protocol to accurately and correctly identify all juvenile salmon to species or implement a sampling program that provides acceptable estimates of species composition if numbers of individual fish preclude genetically identifying each specimen. FWS also recommends that AEA conduct genetic testing and identification of as many individuals as possible to estimate rates of misidentification for all species of juvenile salmon, noting that subsampling ELH catches would provide a more specific species allocation of catches. FWS states that mixed-species designation drastically limits any potential usefulness of the resulting data and should be avoided.

Comments on Requested Study Modifications

AEA acknowledges that it encountered issues with field identification of juvenile salmon and proposes modifications to its methods to improve species identification. AEA states that these modifications are similar to some of the agency recommendations. Specifically, AEA proposes to expand field training in difficult habitats, collect specimens for species analysis, take photographs of field specimens for quality control, and collect genetic samples for genetic verification of species. AEA states that these revisions are described in detail in its *Draft Chinook and Coho Salmon Identification Protocol* and anticipates that implementing the protocol will improve the accuracy of juvenile salmon identification.

AEA indicates that an alevin/fry/parr/smolt life stage index for juvenile salmon allows documentation of physiological state of individual fish and is ancillary data to a length and juvenile life stage designation. AEA states that the FDA Implementation Plan cites fish identification guides, including Weiss (2003) and Pollard et al. (1997), that were used by crews in the field and that these guides include guidance on fry, parr, smolt determination. Additionally, AEA states that fish from a representative subsample of each life stage class were also measured and weighed because the use of a physiological index is subjective. However, because of this subjectivity, AEA did not assign rules regarding size and life stage (i.e., a 55-mm fish had to be a fry or a parr, or that a 100-mm fish had to be a smolt). Rather, the determination was based on the morphology and coloration of the specimen as observed in the field.

Further, AEA asserts that implementing just one element of NMFS and FWS's recommended modifications (aging juvenile fish) would require scale analysis for each fish and that would cost $1,500,000 to implement.

Discussion and Staff Recommendation

As AEA notes, it encountered issues with field identification of juvenile salmon during 2013, especially when attempting to distinguish between juvenile Chinook and coho salmon. AEA proposes modifications that should substantially improve the accuracy of juvenile fish identification during the next study season. Although the modifications recommended by NMFS and FWS could further improve the accuracy of

the species identification, they would also increase the level of effort and cost of the study (section 5.9(b)(7)) by a minimum of up to $1,500,000, and it is not clear to us whether the recommended modifications would significantly increase the accuracy when compared to AEA's proposed methods. Therefore, we do not recommend any modifications to the study plan beyond what AEA proposes.

Sampling Beaver Complexes

Requested Study Modifications

NMFS recommends modifying the study to address the relative importance of beaver ponds and complexes for juvenile salmon summer rearing and overwintering. Specifically, to test for differences in the relative abundance and size distribution of juvenile salmon in these habitats, NMFS recommends that AEA sample macrohabitats in beaver ponds and in comparable macrohabitats without beaver ponds at a minimum of 10 middle river and 10 lower river locations during the summer. NMFS recommends establishing 200-meter-long sampling units and using 20 baited minnow traps set for at least 20 hours and spaced about 10 meters apart. NMFS contends that this information will be used to evaluate the relative effects of project operations on the development and establishment of beaver ponds and project operations that may affect fish access to beaver ponds and pond complexes.

Comments on Requested Study Modifications

AEA states that is has extensively sampled beaver complexes as part of FDA sampling at all sampling locations where they are present. AEA indicates that beaver complexes were particularly abundant within slough habitats and that it was rare that beaver complexes were completely absent within an entire slough macrohabitat.

Discussion and Staff Recommendation

It is unclear why this recommended modification is needed (section 5.9(b)(4)). As noted by AEA, the approved study plan already provides for sampling beaver complexes when they are encountered within sampling units. AEA's sampling results should provide sufficient information to determine the relative importance of these habitat features for juvenile salmon rearing and overwintering. For these reasons, we do not recommend modifying the study plan.

Study 9.7 – Salmon Escapement

Background

The purpose of study 9.7 is to provide information on the distribution and abundance of adult salmon in the Susitna River. Under this study, the Susitna River was divided into the following three segments: Lower River (approximately PRM 33–102.4),

Middle River (approximately PRM 102.4–187.1), and Upper River (PRM 187.1– 261.3). Of the eight objectives for this study, the following are relevant to this determination: (1) capture, radio-tag, and track adult salmon (study objective 1); (2) determine the migration behavior and spawning locations of the radio-tagged salmon in the Lower Middle, and Upper River (study objective 2); (3) if shown to be an effective sampling method, and where feasible, use sonar to aid in documenting salmon spawning locations in turbid water (study objective 4); and (4) estimate the system-wide Chinook salmon and coho salmon escapement to the Susitna River above the Yentna River and the distribution of those fish among tributaries of the Susitna River (study objective 8).

AEA implemented the study during 2012, 2013, and 2014. The study is complete, and AEA proposes no additional data collection or analyses.

Additional Year of Study to Address Size Selectivity Bias and Increase Accuracy of Escapement Estimates

Requested Study Modifications

NMFS states that the study objectives were not met primarily because of the size selectivity bias in AEA's sampling methods. Therefore, NMFS recommends that AEA conduct additional spawning ground surveys to obtain size distributions for comparison with tagged fish, identify any size selection bias for fish tagged from fish wheel sampling, and obtain more accurate assessments of mark rates and escapement. NMFS states that the additional information is needed to meet several of the study objectives specified in the approved study plan. This recommendation is based on the following assertions by NMFS: (1) spaghetti tagging and subsequent spawning ground surveys were not conducted for analysis of equal vulnerability of capture and tagging; (2) fixed-site sonar did not allow observers to differentiate species or to accurately collect length data; (3) video at weir sites did not document the presence of tags; (4) observers had difficulty determining numbers and species of passing fish and obtaining measurements of fish total length during high flows and no calibration of sonar or video length data took place to remedy this potential source of error; (5) the Adaptive Resolution Imaging Sonar (ARIS) unit at site 1 intended to check for bias in fishwheel sampling was not operated during the peak of the coho salmon run; (6) the Indian River weir did not accurately represent the coho salmon run during 2013 because weir counts stopped the day after the observed peak of the run; (7) Indian River weir failure during 2014 impaired the accuracy of mark rate and size-selectivity analysis in the Middle River and Upper River and biased the estimated escapement values; (8) no fish were sampled for size at spawning grounds above Middle River tagging sites; and (9) in 2013, too few coho, pink, sockeye, and chum salmon were recaptured at weir sites to test for size selectivity in the Middle River.

Comments on Requested Study Modifications

AEA states that the size selectivity analysis provided in the October 2015, study completion report (SCR) identified no significant size selection sampling bias for Chinook and coho salmon at Middle River fishwheels based on sampling at the Indian River weir in 2013 and inferences from sonar at Middle River tagging sites in 2014. AEA states that all size classes of salmon were captured at each Middle River fishwheel, indicating that fish of all lengths were subject to capture, further corroborating the 2013 weir findings that size-selectivity did not introduce significant bias to study results. AEA acknowledges that tagging efforts for small Chinook and pink salmon were not random at the Middle River fishwheels in 2013 and 2014 because of size constraints of the tags used, which did not fit into the stomach of smaller fish. However, AEA states that this bias did not prevent it from meeting study objective 1 because the difference in mean length between captured and radio-tagged pink salmon was very small and, although Chinook salmon that were too small to tag made up a large proportion of captured fish, none of those large enough to tag passed above Devils Canyon during the three study years. Conversely, AEA notes that some size selectivity was identified for capture of smaller Chinook salmon and coho salmon at Lower River sites. Nevertheless, AEA reports that substantial numbers of all size classes of Chinook and coho salmon were detected at recapture sites. AEA states that very large numbers of both small and large radio-tagged fish in this study provided robust statistical power for both evaluating size selectivity and estimating abundance and distribution of spawning Chinook and coho salmon. AEA asserts that the effects of size selectivity of Lower River tagging were effectively minimized by size-stratification in estimates of abundance and distribution of spawning Chinook and coho salmon based on mark-recapture estimates. Therefore, estimates of proportional fish distribution and escapement are robust and effectively satisfy study objectives.

AEA adds that spawning ground surveys, like those recommended by NMFS, were proven ineffective for collecting size distribution data. In support, AEA argues that carcass surveys conducted in Indian River and Portage Creek to sample fish for mark rates and lengths during 2012 showed it would be unlikely to obtain sufficient numbers of fish through spawning ground surveys to provide a robust mark rate for estimating numbers of fish above Devils Canyon because very few carcasses were found despite excellent survey conditions. AEA suggests that this was because carcasses were removed from the rivers by predators.

Discussion and Staff Recommendation

As described in the approved study plan, AEA expected that size-selectivity from fishwheel sampling was a potential source of bias under this study. Anticipating this potential bias, AEA established large sample sizes and used size-stratification during data analysis to minimize biases; furthermore, in cases where size selectivity was detected, fish were tagged in proportion to their size distribution (i.e., in the Lower River, Chinook

salmon measuring less than 58 centimeters were radio-tagged at approximately one-third the rate of larger fish). Although study variances reduced the amount of data collected, it was sufficient to meet the objectives. Size distribution was obtained for fish tagged in the Lower River (2013 and 2014), the Yentna River (2013), and the Middle River (2013). Size selectivity was directly assessed in some cases; in other cases AEA had to rely on sonar monitoring of fish movement to determine if fish migration paths near the fishwheels varied based on fish length (were larger fish migrating farther from shore and outside the range of the fishwheels) and professional judgement (was the fishwheel placed in a location where fish of all sizes would be funneled into the trap). Finally, bias resulting from size selectivity was reduced to obtain reasonable escapement estimates by using a large sample size (e.g., fish tagged in 2014 included 1,497 fish from the Lower River and 1,453 fish from the Middle River while the total number of fish captured was >30,000), stratifying samples based on fish lengths, and tagging fish in proportion to the observed size range distributions.

Therefore, we find that AEA's methods for addressing potential size-selectivity bias were reasonable and did not affect its ability to meet the study objectives (section 5.9(b)(1)). Moreover, the only way that AEA could address NMFS's concerns would be to duplicate the study for at least one if not two more study seasons. This would be an enormous effort that would require redeploying fish wheels, tagging several hundred to several thousand more adult salmon, tracking the fish upstream through several hundred miles of mainstem and tributary streams, installing and monitoring weirs, and conducting additional spawning ground surveys. We estimate the costs for one additional year of study alone would be between $1,000,000 and $5,000,000 (section 5.9(b)(7)).

We find that the completed study demonstrates that the effect of size-selection bias in sampling was negligible because size selectivity was only detected in some of the cases and AEA used appropriate methods to minimize bias. Therefore, we consider the estimates of fish distribution and escapement throughout the Susitna River Basin to be robust and adequate for our analysis and to develop any necessary license requirements (section 5.9(b)(4)), and we do not recommend requiring AEA to repeat all or a part of the study.

Additional Mainstem Spawning Site Surveys

Requested Study Modifications

NMFS and FWS request that AEA conduct additional radio tagging and ground-based surveys in mainstem habitats in the Lower and Middle River to track tagged salmon to specific spawning locations and identify the physical characteristics of these habitats at the macrohabitat and mesohabitat levels. NMFS states that ground surveys should be directed toward documented mainstem spawning sites that were identified during previous study efforts, and that surveys should be conducted at least weekly to document peak spawning activity.

Comments on Requested Study Modifications

AEA states that the recommended modifications are not necessary to meet the study objectives because the study results already enable it to characterize the migratory behavior and spawning locations for salmon in mainstem and tributary habitats. In support, AEA argues that it radio-tagged and tracked a total of 9,661 salmon over three study seasons from 2012 to 2014 using 23 fixed radio telemetry receivers, and that aerial surveys along almost 30,000 river miles identified several hundred thousand unique tag locations. AEA also notes that extensive surveys conducted during the 1980s corroborate the current spawning distribution results from this study and study 8.5, which found that salmon primarily spawn in tributaries while only a small proportion of salmon spawn within the mainstem.

Discussion and Staff Recommendation

AEA used a combination of fixed telemetry stations and aerial, boat, and ground surveys over a total of three study seasons to track and identify adult salmon spawning locations throughout the Lower, Middle, and Upper River. The results were consistent with the 1980s studies that found that most salmon spawned in tributaries. Although a relatively high percentage of sockeye salmon (i.e., 44 percent) spawned in mainstem habitats, AEA already identified mainstem sockeye salmon spawning sites in many main channel mesohabitats as well as off-channel macrohabitats; therefore, additional radio-tagging and tracking surveys would not likely significantly enhance the existing data set. We conclude that the substantial amount of information collected is sufficient to meet the study objectives (section 5.9(b)(1)) and inform our analysis of project effects on salmon spawning habitat (section 5.9(b)(4)). Therefore, we do not recommend requiring AEA to conduct additional radio tagging, tracking, or ground surveys to identify additional mainstem salmon spawning locations.

Additional Study to Locate Salmon Spawning Sites in Turbid Water

Requested Study Modifications

NMFS recommends that AEA work with the TWG to develop additional methods to locate and document salmon spawning in turbid waters at sites that were classified as mainstem spawning locations in previous tagging studies. NMFS suggests that potential methods could include: (1) gill netting, (2) late September or early October redd surveys during clear water conditions, and (3) pumping or excavating potential redd sites. NMFS asserts that data describing the distribution of salmon spawning in turbid or clear water are necessary to understand the current environment, develop spawning habitat models, and evaluate post-project changes in salmon spawning distribution. NMFS states that because ground surveys were not conducted as provided for in the approved study plan, whether salmon show a preference for main channels, side channels, side sloughs, upland sloughs, or tributary mouths is not known. Additionally, NMFS states that the number of

salmon that spawned in turbid or clear water is unknown. NMFS notes that the use of DIDSON sonar was problematic for several reasons, including the failure to document salmon spawning locations in turbid water, limited utility of boat-mounted sonar units in shallow water and shoreline habitats, and an inability to distinguish between fish species or to identify redds. NMFS states that AEA determined that only Chinook salmon could be distinguished from other species, based solely on their relatively larger length, and asserts that this was an unreported variance from the study plan. Of the potential spawning locations determined by sonar, NMFS states that very few were confirmed.

Comments on Requested Study Modifications

AEA states that methods to meet study objective 4 (*If shown to be an effective sampling method, and where feasible, use sonar to aid in documenting salmon spawning locations in turbid water*) were developed with TWG input and that all of the variances for 2013 work were reported in the ISR, part A, originally filed in January 2014. AEA asserts that study objective 4 was met because it attempted to use sonar to identify spawning location in turbid water, but the methodology was ineffective given the inherent difficulties in sampling the typical mainstem habitat conditions where these salmon species spawn.

Discussion and Staff Recommendation

AEA acknowledged during study plan development that it may be difficult, if not impossible, to observe salmon spawning in turbid water. Nevertheless, AEA agreed to attempt to document salmon spawning in turbid water using a variety of methods including sonar surveys. In 2013, AEA attempted to use sonar and other methods to document salmon spawning locations in turbid water but determined that this and other known sampling techniques were ineffective. In addition, as previously noted, the results of this study coupled with the 1980s study results indicate that most salmon spawn in tributaries and not turbid mainstem habitats. Therefore, expending more effort to attempt to document any additional mainstem spawning sites would be costly (ranging from about $250,000 to $1,000,000) and may not provide any additional useful information. For these reasons, we conclude that AEA implemented the study as required and the information obtained is sufficient to meet the study objectives (section 5.9(b)(1)). Therefore, we do not recommend requiring AEA to consult with the TWG and develop additional methods or conduct additional surveys to document salmon spawning in turbid mainstem habitats.

Additional Year of Study in the Middle River Segment

Requested Study Modifications

NMFS states that the study results indicate problems with study implementation because the results document much lower coho salmon escapement and mainstem chum

salmon and sockeye salmon spawning in the lower Middle River compared to studies conducted in the 1980s. NMFS also states that land access constraints prevented AEA from fully implementing the methods in the approved study plan because it was unable to install a fishwheel immediately below Devils Canyon. Therefore, NMFS recommends that AEA conduct an additional year of fish capture and tagging studies in the lower section of the Middle River near the historic Talkeetna Station and at a second location upstream from Indian River but close to Devils Canyon. NMFS recommends that AEA conduct an *a priori* statistical analysis to determine the appropriate number of additional tagged fish required to yield sufficient identification of spawning sites for each species in the lower section of the Middle River. NMFS also recommends that AEA install and maintain weirs on the mainstem Susitna River at or upstream of the head of the proposed reservoir and at Kosina Creek and the Oshetna River to recapture tagged fish and for additional genetic sampling.

Comments on Requested Study Modifications

AEA opposes NMFS's recommended study plan modification. AEA states that it implemented steps to address the lack of a Devils Canyon fishwheel capture and tagging site and that it used multiple methods to corroborate estimates of the relative proportion and abundance of Chinook salmon adults occurring upstream of Devils Canyon. AEA contends that NMFS provides no objective criteria as guidance for an *a priori* statistical analysis of the number of additional tagged fish required to yield "sufficient" identification of spawning habitat locations in the lower Middle River site. AEA also contends that the Upper River weir locations recommended by NMFS are not suitable due to the wide channel, highly variable flow conditions, and water depths that prevent safe weir operations because they are either too deep or too swift to allow for safe wading across the channel.

Discussion and Staff Recommendation

Although land access constraints, unfavorable channel conditions, and high flow events required AEA to modify its study approach to estimate the system-wide Chinook salmon and coho salmon escapement above the Yentna River and the distribution of those fish among tributaries of the Susitna River, AEA carried out the study to the extent feasible and adequately mitigated the effects of these variances by adding a third fishwheel in the Middle River and increasing the number of radio tagged Chinook salmon from 400 to 650. We find that the results of this study satisfy this study objective (section 5.9(b)(1)) and the information collected is adequate to inform our analysis and to develop license requirements (section 5.9(b)(4)). Additionally, as noted above, the costs to duplicate all or a portion of this study for one year would be very high, ranging from $1,000,000 to $5,000,000 (section 5.9(b)(7)), and we are not convinced that the additional data collected by such efforts would significantly add to the existing large data set compiled from studies carried out during the 1980s and from 2012 through 2014.

Therefore, we do not recommend requiring AEA to repeat a portion of this study in the Middle River segment.

Effects of Radio Tagging on Swimming Ability and Estimating Salmon Abundance Upstream of the Dam Site

Requested Study Modifications

FWS states that radio tagging has been shown to potentially affect swimming capabilities and natural behavioral tendencies of fish.[19] FWS states that radio tagging may have introduced a bias to the study by altering swimming abilities or behavioral tendencies in fish destined for the Upper River, thus causing the study results to underestimate the population size of Upper River Chinook salmon and incorrectly exclude other species with similar swimming abilities (i.e., coho and sockeye salmon) from the Upper River segment. FWS therefore recommends that AEA evaluate methods other than radio tagging for assessing upstream migration capabilities and population estimates in the Upper River for Chinook, coho, and sockeye salmon.

Comments on Requested Study Modifications

AEA states that it analyzed the potential effects of radio-tagging on swimming ability and behavior and presented the results in study 9.7, ISR, part A, section 5.1.5, and study 9.7 SCR, section 5.1.4. AEA states that the results indicate no detectable behavioral response to tagging.

Discussion and Staff Recommendation

Comparisons of travel times between recently tagged and distantly tagged fish showed higher swimming rates for fish that were recently tagged. Comparisons of post-release migratory behavior between once-handled fish (fish that were never recaptured) and multiple handled fish (fish that were recaptured in fishwheels post-release) showed that large Chinook salmon that were handled twice had a lower percent of individuals with assigned spawning locations compared to fish handled only once (53 percent compared to 80 percent); however, all other salmon assessed in this way showed negligible impacts to behavior. Although large Chinook salmon behavior was negatively affected after multiple handling events, it is likely that the proportion of fish in study 9.7 that exhibited handling-induced behavior changes from tagging is lower because most fish were only handled once; furthermore, the comparison of swim rates suggests even lower impacts resulting from handing. Based on these results, we agree with AEA's conclusion that the handling and tagging effects were minimal. Therefore, AEA's study

[19] FWS's comment was directed at study 9.11, but we find it more appropriate to address under study 9.7.

results are adequate to meet the study objectives (section 5.9(b)(1)) and inform our analysis (section 5.9(b)(4)), and we do not recommend requiring AEA to develop and implement additional methods to determine the population sizes of salmon species in the Upper River.

Additional Study to Determine Species Composition of Salmon Migrating into Upper River above the Dam Site

Requested Study Modifications

FWS recommends that AEA evaluate the potential effects of the anomalous hydrologic conditions in the Susitna River in 2012 and 2013, in particular unusually high late summer flows, on salmon species passing Devils Canyon into the Upper River. FWS recommends that AEA evaluate whether these higher than normal late summer and early fall flows affected the ability of Chinook, coho, and sockeye salmon to migrate through Devils Canyon and into the Upper River. FWS further states that large coho salmon have swimming capabilities similar to those of Chinook salmon and established populations of coho salmon exist in the Susitna River, yet AEA did not observe this species the Upper River. FWS also indicates that an Alaska DFG biologist observed sockeye salmon above the dam site in the 1980s; however, the biologist did not photograph the observation so the information is not being used in the fish presence studies, yet it should be. FWS therefore recommends that AEA further investigate coho and sockeye salmon passage through Devil's Canyon into the Upper River.

Comments on Requested Study Modifications

AEA states that despite numerous efforts to document salmon distribution upstream of Devils Canyon, no salmon species besides Chinook salmon has ever been documented. AEA contends that the FWS's notion that an Alaska DFG fish biologist anecdotally noted many sockeye salmon adults near the mouth of the Oshetna River has never been substantiated, and Alaska DFG does not have any documentation of this occurrence in its Anadromous Waters Catalogue.[20]

In support, AEA argues that it has conducted surveys in the Upper River in 2012, 2013, and 2014, and with the next year of study implementation for studies 9.5 and 9.6, AEA will have collected data over four calendar years. AEA states that through these efforts it has collected a total of 21,380 fish in the Upper River, radio-tagged and tracked 9,600 adult salmon, and conducted spawner surveys for three years in the Upper River. AEA indicates that all of the data collected are consistent with previous studies by Alaska DFG in the 1980s and in 2003, which all show that Chinook salmon is the only anadromous salmon species present in the Upper River and that it occurs in very low abundance with a limited and patchy distribution.

[20] Available online at: http://www.sf.adfg.state.ak.us/SARR/AWC/index.cfm

Discussion and Staff Recommendation

All available information suggests that Chinook salmon is the only anadromous fish species that is able to successfully migrate through Devils Canyon and access habitat in the Upper River above the proposed dam site. This information is based on nine years of radio-tagging of multiple species of adult salmon, seven years of aerial spawner surveys, and six years of juvenile fish sampling conducted in the 1980s and from 2012 to 2014, spanning years with a wide range of hydrological conditions. Based on this substantial amount of existing information (section 5.9(b)(4)), we see no evidence to suggest that other anadromous salmon species are present above the dam site, and we do not recommend requiring AEA to expend more effort than it already proposes through ongoing implementation of study 9.5 to further evaluate the extent of Chinook salmon or other anadromous salmonid presence in the Upper River.

Study 9.8 – River Productivity

Background

The purpose of the study is to collect baseline data to support an effects analysis of project-induced changes in flow and the interrelated environmental factors on the benthic macroinvertebrate and algal communities in different habitat types in the Middle and Lower River. The study objectives include: (1) synthesizing existing literature on the impacts of hydropower development and operations (including temperature and turbidity) on benthic macroinvertebrate and algal communities; (2) characterizing the existing species composition and abundance of benthic macroinvertebrate and algal communities in the Middle and Lower River; (3) estimating drift of benthic macroinvertebrates in selected habitats within the Middle and Lower River to assess food availability to juvenile and resident fishes; (4) evaluating the suitability of using reference sites on the Talkeetna River to monitor long-term project-related change in benthic productivity; (5) conducting a trophic analysis to describe the food web relationships within the current riverine community within the Middle and Lower River; (6) developing HSC for benthic macroinvertebrates and algal habitats; (7) characterizing the invertebrate compositions in the diets of representative fish species in relationship to their source (benthic or drift component); (8) characterizing coarse particulate organic matter, fine particulate organic matter, and suspended organic matter; and (9) estimating benthic macroinvertebrate colonization rates in the Middle River.

Literature Review Key Words and Databases

Requested Study Modifications

NMFS and FWS state that AEA's literature review summarizing hydroelectric development and operations on benthic macroinvertebrate and algal communities is incomplete because 27 of the 53 published papers that NMFS identified as important

when conducting a similar limited search were omitted from the document. Further they argue that AEA does not provide the methodology it followed in conducting the literature search. Both NMFS and FWS recommend AEA provide a list of the key words and databases and any other methods used to develop the literature review, and, that AEA improve the review with more recent publications. NMFS and FWS also recommend AEA include a review of literature addressing changes to river productivity arising from climate change.

Comments on Requested Study Modifications

AEA asserts that the literature review was performed in accordance with the approved study plan and completes the study objective. AEA states that its literature review identifies and summaries 500 relevant reports and publications on macroinvertebrate and algal community information in Alaska; the general influences of changes in flow, temperature, substrates, nutrients, organic matter, turbidity, light penetration, and riparian habitat on benthic communities; and the potential effects of dams and hydropower operations, including flushing flows and load-following, on benthic communities and their habitats. AEA states that it does not discuss effects of climate change on river productivity in the literature review because an assessment of effects of climate change on river productivity is not required.

Discussion and Staff Recommendation

The approved study plan requires AEA to provide a report summarizing relevant literature on the effects of hydropower project operations on Alaskan macroinvertebrate and algal communities and their habitats (e.g., changes in flow, temperature, substrate, nutrients, organic matter, turbidity, and riparian habitats). Based on our review of the report, AEA provided a robust synthesis of existing literature on the effects of hydropower operations, including the proposed project operations, on benthic communities with reference to glacial systems (section 5.9(b)(4)). Having AEA provide the literature search criteria and methods is not necessary to support our analysis of project effects; therefore, we do not recommend modifying the study as requested by NMFS and FWS. We do, however, encourage NMFS and FWS to file, with the Commission, any reports and published papers they feel were omitted from the report and relevant to our environmental analysis of the proposed project.

Benthic Sample Spacing and Proximity throughout the Sampling Area

Requested Study Modifications

NFMS and FWS assert that benthic samples within each macrohabitat were collected too close to each other; therefore, they are not representative of the five macrohabitat types that were to be sampled (i.e., tributary mouth, upland slough, side slough, side channel, and main channel) and reduce the variability of water depths, water

velocities, and substrate information to be used to inform the development of HSC for benthic macroinvertebrates. In addition, NMFS and FWS state that benthic samples were not distributed throughout the macrohabitat as specified in the study plan, which requires AEA to collect samples randomly or systematically throughout each 200- or 500-meter-long macrohabitat unit or at units that are equal to 20 times the channel width in length. Therefore, NMFS and FWS recommend that AEA discard the prior samples and repeat sampling at equally spaced distances within each sampling unit.

Comments on Requested Study Modifications

AEA states that, while sampling unit lengths for studies 9.5 and 9.6 consist of 200-meter, 500-meter, or 20-times-the-stream-width standard sampling unit designations, nowhere in the approved study plan for study 9.8 does AEA propose to delineate river productivity sampling units into specific 200-meter, 500-meter or 20-times-the-stream-width standard reach lengths as NMFS and FWS assert.

AEA states that, due to the large number of sites and the intensive amount of sampling involved in the this study, it developed a sampling approach focused on sampling coarser substrates and faster velocities, i.e., riffle/run habitats (the richest-targeted habitat) because: (1) these areas are higher in macroinvertebrate diversity and abundance; and (2) they offer a level of standardization in terms of habitat stratification, which reduces sample variability and facilitates comparisons among sites. AEA states that NMFS and FWS's comments on the sampling locations and distances between samples appears to rely on the site-specific images supplied in the ISR part A, appendix B and the study 9.8 SIR, appendix B. However, AEA indicates that NMFS and FWS have misinterpreted the intent of providing these graphics, which were to be used to show approximate locations of each site and where sampling occurred within those sites, not to measure precise locations down to 10 meters or less. AEA notes that, while several sites do reveal samples being taken close together, measurements from the center of each marker to the next closest marker often reveals that samples were spaced a minimum of 10 meters as it proposes in the approved study plan.

AEA explains that sample units ranged in length from approximately 10 to 210 meters, with the distance between benthic sample locations within a given sample (habitat) unit ranging from about 5 to 56 meters.

Discussion and Staff Recommendation

The approved study plan does not require AEA to collect benthic samples at a specified distance or spacing between samples, nor does it require AEA to delineate macrohabitats into benthic sampling units that are 200 meters, 500 meters, or 20-times-the-channel-width in length. Instead, it states that AEA should "strive" to space benthic macroinvertebrate samples every 10 meters. Based on the information provided in AEA's reply comments and summarized above, it appears as though AEA collected the benthic samples as required by the approved study plan. In some cases, AEA collected

samples that were less than 10 meters apart, but this appears to be because the sample units themselves were small and spacing at greater increments would have reduced the overall number of samples. We therefore conclude that AEA collected its samples as required by the approved study plan and in a manner that will be enable it to meet the study objectives (section 5.9(b)(1)) and inform our analysis (section 5.9(b)(4)). We do not recommend requiring AEA to discard any samples and repeat benthic community sampling at equally spaced intervals within macrohabitat sampling units as recommended by NMFS and FWS.

Tributary Mouth Macrohabitat Selection

Requested Study Modifications

NMFS and FWS assert that the number of tributary mouths sampled within the Middle River segment (two downstream of Devils Canyon) is insufficient to evaluate the value of tributary mouth habitat to juvenile salmon and resident fish species. NFMS and FWS also raise concerns that no sample was collected from within a clear water tributary plume that extends into the main channel of the Susitna River. Therefore, NMFS and FWS recommend that AEA repeat benthic macroinvertebrate, benthic organic matter, and periphytic algae sampling at each tributary mouth sampling location and at various water depths and velocities and at various flows and seasons in accordance with the study plan. NMFS and FWS also continue to recommend as they did in their comments on the RSP that AEA sample six additional tributary mouths within the Middle River below Devils Canyon: Portage Creek at FA-158, an unnamed tributary at FA-144, Gold Creek at FA-138, Skull Creek at FA-128, an unnamed tributary at FA-115, and Gash Creek at FA-114.

Comments on Requested Study Modification

AEA states that tributary mouth habitat selection was based on results of aquatic habitat mapping in the Middle and Lower River, and that the approved study plan requires sampling at five tributary mouth macrohabitats. AEA states that it sampled five sites as required by the approved study plan, and the information it collected is sufficient to meet the study objective of characterizing the species composition and abundance of benthic macroinvertebrate and algal communities within these tributary macrohabitats in the Middle and Lower Susitna River. AEA asserts that sampling six additional tributary mouths within the Middle River is not needed to characterize tributary mouth habitat or to support a project-level effects analysis, and that this recommendation was already addressed in the April 1, 2013, study determination. AEA reports that the initial sampling results across all habitat types show that tributary mouths and sloughs were

generally highest in mean benthic density, taxa richness, and EPT[21] richness, and often showed higher percentages of those EPT taxa in community compositions. Therefore, AEA's efforts in collecting benthic community data from tributary mouths are adequate, and are accomplishing the stated study objective of providing a baseline characterization of these habitats.

With regard to sampling in clear water plumes, AEA states that clear water plumes were not designated as tributary mouth habitat but rather as mainstem macrohabitat; therefore, field crews were instructed not to sample them as a component of the tributary mouth macrohabitat sampling efforts.

Discussion and Staff Recommendation

The approved study plan requires AEA to sample benthic macroinvertebrates, algae, and organic matter at four tributary mouth macrohabitats in the Middle River and one tributary mouth macrohabitat in the Lower River. The intent of this sampling is to provide a baseline characterization of benthic communities within tributary mouths. AEA reports that it sampled the benthic macroinvertebrate, algae, and organic matter communities at four tributary mouth macrohabitats in the Middle River (i.e., FA-141, FA-173, FA-184, and FA-104) and one in the Lower River at site RP-81. However, Figure 4.2-4 of the study 9.8 ISR shows that Whiskers Creek flows into Whiskers Slough (classified as a side slough). This sampling site should not be characterized as a tributary mouth according to AEA's channel classification system because AEA's definition of a tributary mouth macrohabitat specifies that the tributary mouth discharges into a mainstem main channel or side channel habitat (not a side slough).[22] Therefore, the data collected within Whiskers Slough should be used to represent side slough habitat, rather than a tributary mouth.

Although AEA only sampled three of the four Middle River tributary mouths required by the approved study plan, the data collected to date are sufficient to meet the study objective of characterizing benthic communities within tributary mouths in the Middle River (section 5.9(b)(1)). The collected data show that tributary mouths are productive benthic habitats that tend to be occupied by sensitive taxa such as stoneflies and caddisflies. Therefore, the additional sampling is not needed (section 5.9(b)(4)). For these reasons, we do not recommend requiring AEA to repeat or expand the tributary mouth sampling during the next study season.

With regard to sampling within clear water plumes, as discussed in our analysis for study 9.9, AEA classified and sampled these habitats according to the approved study plan. This included classifying clear water plumes as Level 4 mesohabitats within Level

[21] AEA defines "EPT" as insect orders of typically sensitive taxa, including Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies).

[22] See table 9.9-5 of the study 9.8 final study plan.

3 main and side channel macrohabitats and not including clear water plumes within tributary mouth macrohabitats. Therefore, no modifications to the study plan are needed.

Upland Slough Macrohabitat Selection

Requested Study Modifications

NMFS and FWS argue that the upland slough that AEA sampled at Montana Creek (site RP-81) is actually part of Montana Creek and is not an upland slough because it is not a Susitna River overflow channel; therefore, this data should be discarded and not used to represent upland slough habitat in the Lower River. NMFS and FWS contend that if the data from this site are discarded, then AEA actually only sampled two upland slough macrohabitats throughout the entire Susitna River (both in the Middle River). As a result, NMFS and FWS request that AEA repeat sampling of benthic macroinvertebrates, macroinvertebrate drift, benthic organic matter, and periphytic algae within the two previously sampled upland slough macrohabitats (FA-104 and FA-141) and at three additional upland slough macrohabitats (FA-115, FA-138, and FA-144) in the Middle River below Devils Canyon.

NMFS and FWS note that the upland slough at FA-141 was not co-located with FDA sampling as specified in the approved study plan and request that AEA co-locate all river productivity and fish distribution and abundance (study 9.6) sampling sites at all five of their recommended upland slough sampling locations.

Comments on Requested Study Modifications

AEA argues that NMFS and FWS's comments regarding upland slough sampling reflect their fundamental disagreement with the approved study plan. AEA contends that NMFS and FWS have discounted the location of established sites, the macrohabitat classifications at the sites, where sampling occurred within sites, and the number of sites that must be sampled as presented in section 2.1 of the study implementation plan and the study plan determination. AEA states that it actually sampled three upland slough macrohabitats in the Middle River and one in the Lower River, which is more than is required by the approved study plan. AEA also disagrees with the NMFS and FWS's comments that the Montana Creek upland slough site (RP-81) should not be characterized as an upland slough, again reiterating that this appears to be based on a fundamental disagreement with how AEA classified some of the habitats in the study area.

AEA disagrees with NMFS and FWS's comments regarding the appropriateness of the sampling locations within FA-141. AEA believes these comments indicate some misunderstanding of AEA's efforts at the FA-141 upland slough site. The river productivity upland slough sampling site (site RP-141-4) in FA-141 was sampled by both a Ponar grab sampler and a Hess sampler. Within this slough, AEA sampled the slow water area that had fine substrates with the grab sampler and plankton tow net. While on site, crews found that the water source was farther upstream and there was an area of

upwelling with extremely cold and clear water. AEA also sampled the small upwelling area with a Hess sampler to collect potentially valuable information within this unique upwelling area. However, because of the small size of this upwelling area, samples were collected in close proximity within this site.

AEA states that it did not co-locate river productivity and fish sampling sites in 2013 at the upland slough within FA-141 because the fish sampling site was within a beaver complex, which was not a targeted habitat for river productivity sampling, and the upland slough behind the beaver complex was marshy and lacked sufficient open water to effectively sample using a Hess or Ponar grab sampler. Therefore, AEA selected a different upland slough within FA-141 for the river productivity sampling in 2013, but that it sampled the site for fish abundance in 2014 and found juvenile Chinook salmon. Therefore, fish sampling data are available for the river productivity sampling site at FA-141.

Discuss and Staff Recommendation

The approved study plan requires AEA to sample the benthic communities within two upland sloughs in the Middle River Focus Areas (FA-141 and FA-104) and at one upland slough in the Lower River (RP-92, Trapper Creek Complex). AEA sampled one upland slough macrohabitat upstream of Devils Canyon (FA-173, Stephans Lake Complex) and two upland sloughs within the Middle River downstream of Devils Canyon (FA-141 Indian River and FA-104 Whiskers Slough). AEA completed the Middle River upland slough sampling as required by the approved study plan, and the data are sufficient to meet the study objective of characterizing the benthic communities within Middle River upland slough macrohabitats (section 5.9(b)(1)). Therefore, we do not recommend requiring AEA to conduct additional benthic community sampling in Middle River upland sloughs as recommended by NMFS and FWS.

As noted in the ISR, AEA moved the Lower River sampling site from Trapper Creek to Montana Creek because Trapper Creek is not a suitable location for fish sampling, and such sampling is needed to support trophic modeling and stable isotope and fish diet analyses. Although NMFS and FWS contend that the Montana Creek site that AEA sampled as an upland slough is not a slough and the data should be discarded, there is insufficient information available at this time to determine whether or not RP-81 should be classified as an upland slough. AEA defines an upland slough as an overflow channel contained in the floodplain that has a vegetated bar at the head that is rarely overtopped by mainstem flows. We cannot tell based on the aerial photos whether the upland slough sample site meets this definition. Therefore, we recommend that AEA describe in the USR how the slough at RP-81 functions like an upland slough and justify the use of the data collected there.

Side Slough Macrohabitat Selection

Requested Study Modifications

NMFS and FWS state that AEA did not select side slough macrohabitats as required in the study plan. NMFS and FWS state that side slough macrohabitat is present in Montana Creek at site RP-81 but was not sampled.

NMFS and FWS state that the sampling site at the Whiskers Creek/Whiskers Slough confluence was actually sampled within the Whiskers Creek tributary, and therefore, should not be used to represent the benthic community of side slough macrohabitat. NMFS and FWS argue that only two side slough macrohabitats were sampled, of which only one was in the Middle River below Devils Canyon. Therefore, NMFS and FWS request that AEA repeat the sampling effort at a minimum of six side slough macrohabitats in FA-104, FA-114, FA-128, FA-138, FA-141, and FA-144, following the methods required by the study plan.

Comments on Requested Study Modifications

AEA states that relocating the Lower River study station from Trapper Creek (RP-92) to Montana Creek (RP-81) resulted in the loss of one side slough macrohabitat because there were no side sloughs present at Montana Creek, which reduced the total number of side slough macrohabitats to be sampled from four to three. AEA asserts that what NMFS and FWS indicates is side slough macrohabitat at Montana Creek is actually a vegetated island side channel complex. AEA also indicates that it only sampled two of the three Middle River side sloughs that it proposed to sample in the study plan, thereby reducing the total number of side sloughs it sampled from four to two within both the Middle and Lower River segments.

To fulfill the study requirement of sampling four side sloughs, AEA proposes to sample two additional Middle River side slough sites, one downstream of the Indian River and the other either at FA-138 or FA-128 during the next study season. AEA does not propose any additional side slough sampling in the Lower River to compensate for the loss of a side slough sampling site when it moved the Lower River sampling station from Trapper Creek to Montana Creek.

AEA also disagrees with NMFS and FWS's assertion that no side slough macrohabitat was sampled at FA-104 (Whiskers Creek). AEA states that the Whiskers Slough side slough macrohabitat sampling site (site RP-104-2) consisted of samples collected at both the upper and lower ends of the side slough (not in Whiskers Creek); therefore, these data should not be discarded.

Discussion and Staff Recommendation

AEA acknowledges that it under sampled side slough macrohabitats and proposes to collect additional samples at two Middle River side sloughs to correct this sampling

deficiency. Although we agree with AEA that additional side slough sampling is needed in the Middle River, we disagree that both sites should be selected in the Middle River and none should be selected in the Lower River. Some information on the benthic communities within side slough habitat in the Lower River is needed to characterize the benthic communities within this river segment. Adding a side slough sampling site in each river segment would enable AEA to better characterize and evaluate longitudinal trends, and discern differences in macroinvertebrates, algae, and organic matter among the macrohabitat types and river segments.

Therefore, we recommend that AEA sample one side slough macrohabitat in each of the Middle and Lower River segments during the next study season. If there are no side sloughs at Montana Creek that meet AEA's definition of a side slough under its habitat classification system, then we recommend that AEA sample an appropriate side slough elsewhere in the Lower River. In both cases, AEA should consult with the TWG prior to selecting the Middle River and Lower River side slough sampling sites.

For the reasons stated above in our discussion of tributary mouth macrohabitat sampling, we agree with AEA that samples collected at Whiskers Slough site RP-104-2 are representative of side slough habitat and therefore the data collected at this site appropriately characterize benthic communities within side slough macrohabitats and should not be discarded.

Additionally, we see no reason to require AEA to expand side slough sampling to an additional six Middle River sites as recommended by NMFS and FWS. At this point AEA's proposed side slough sampling is incomplete and ongoing but we anticipate that existing data it has already collected plus the additional data we recommend it collect during the next study season will be sufficient to meet the study objectives of characterizing benthic macroinvertebrates, algae, and organic matter in Middle and Lower River side slough macrohabitats (section 5.9(b)(1)).

Side Channel Macrohabitat Selection

Requested Study Modifications

NMFS and FWS state that AEA did not sample side channel macrohabitats as required by the approved study plan because it sampled inappropriate side channel habitat. Specifically, NMFS and FWS state the side channel habitat sampled at FA-184 was misclassified because the sample site was at the head of a single island adjacent to the main channel. NMFS and FWS add that the areas sampled at FA-173, FA-141, FA-104 are actually a side slough, an ephemeral channel, and upland slough habitats, respectively. As a result, NMFS and FWS request AEA discard the benthic sampling results and repeat sampling at a minimum of six side-channel macrohabitats that are representative of side channel macrohabitats in the Middle River downstream of Devils Canyon. To accomplish this, NFMS and FWS recommend that AEA sample side channels at the following study sites: FA-144, FA-141, FA-138, FA-115 or FA-114, FA-

104, and downstream of RP-81 Montana Creek. NMFS and FWS also suggest that the selected side channel macrohabitats should not be within an upland slough or other macrohabitat type.

Comments on Requested Study Modifications

AEA states that side channel macrohabitats were selected based on habitat mapping. AEA also notes the aquatic habitat maps represent a snap shot in time and during the spring sampling event, flows were higher and the two side channel habitats at FA-141 and FA-173 functioned as side channel habitats. However, during the summer and fall sampling events those same sites functioned as side slough habitat. AEA also states it disagrees with NMFS and FWS habitat classifications at FA-184 and FA-104, and affirms that side channel samples were clearly taken on the opposite side of the island from the main channel site and the samples collected at FA-104 were not collected within the upland slough.

In addition, AEA argues that discarding all side channel data and repeating the sampling effort at the requested six side channel locations is not consistent with study objective 2 because it disregards the extent of the Middle River that is upstream of Devils Canyon where the benthic macroinvertebrate community would be most affected by project operations. As an alternative, AEA proposes to sample two new side channel macrohabitats at the river productivity sampling stations in FA-141 and FA-173 (RP-141 and RP-173) that are less affected by river flows than the sites it previously sampled at these locations.

Discussion and Staff Recommendation

As discussed elsewhere in this determination, the disagreement between the agencies and AEA about the appropriateness of the selected sample sites seems to be based on differences in opinion about how some habitats were classified. However, based on our review of the aerial photos and maps contained in the study reports, with the exception of the side channels sampled within FA-141 and FA-173, we find that AEA appropriately classified the side channels that it selected for river productivity sampling. The benthic community data collected within the side channels in FA-141 and FA-173 should be reclassified as side sloughs, and recommend that AEA collect additional samples at RP-141 and RP-173 within these two Focus Areas as it proposes because they better represent side channel habitat.

We see no reason to require AEA to discard any of the data or expand the side-channel sampling to six additional sites as recommended by NMFS and FWS, and we do not recommend requiring it to do so.

Main Channel Macrohabitat Selection

Requested Study Modifications

NMFS and FWS state that benthic community sampling of main channel macrohabitats did not comply with the approved study plan because the sampling areas were not clearly located in a main channel macrohabitat. Specifically, NMFS and FWS state the main channel sampling locations at FA-184 were located too close to the side channel sampling locations on the same point, main channel habitat at FA-141 was not sampled, and side channel habitat at FA-104 and RP-81 was used to represent main channel habitat for the spring sampling event. As such, NMFS recommends that the data collected within main channel macrohabitats not be used to address study objectives

Comments on Requested Study Modifications

AEA affirms that all main channel macrohabitat sites were properly established in locations that are representative of main channel macrohabitats, and sampling at those macrohabitats achieved the study objectives.

Discussion and Staff Recommendation

NMFS and FWS believe that AEA should have selected and sampled areas within FA-184, FA-141, FA-104 and RP-81 that are definitively main channel macrohabitats. The study reports indicate that the main channel macrohabitat sample sites at FA-184 was located at the upstream end of an island, very near to the side channel sampling locations, but within the main channel flow (see Appendix B, Figure B-20 of the ISR Part A). Similarly, the main channel sample area at FA-104 was also at an upstream end of an island and within habitat classified as main channel (see Appendix B, Figure B-7 of the ISR Part A and Appendix A, Map 54 of Study 9.9 Study Completion Report). Thus, AEA sampled appropriate main channel habitat at FA-141 and RP-81, because these areas appear to be multiple split main channel and split main channel macrohabitats, respectively. Consequently, the macrohabitats selected by AEA provide a diversity of main channel macrohabitats represented throughout the Susitna River. While sampling additional replicate main channel macrohabitats as requested by NMFS and FWS would provide additional information, it would be costly and is not needed to characterize the baseline benthic community within main channel macrohabitats downstream of the proposed project (sections 5.9(b)(4) and (7)).

Sampling Depth for Benthic Communities in Main and Side Channel Habitats

Requested Study Modifications

NMFS and FWS state that AEA's overuse of Hess samplers to collect benthic macroinvertebrates and algal samples resulted in the sampling of areas that are not representative of the associated macrohabitats and the sampling of areas that had been

dewatered during the previous 30 days. NMFS and FWS also state that because Hess samplers are limited to sampling shallow rocky areas, they do not provide a range of depths and substrate necessary to develop HSC/HSI that would be representative of macroinvertebrates in the active channel (study objective 6). Therefore, NMFS and FWS request that AEA collect macroinvertebrate samples from locations that remain wet under most flow conditions and at a range of depths within main channel and side channel macrohabitats; alternative methods such as dome samplers, box sampler, or an airlift sampler could be employed, if they are better suited to sampling the full range of habitat conditions within these habitats. NMFS and FWS also recommend that AEA discard any samples that were collected from habitats that were dewatered within 30 days of sample collection.

Comments on Requested Study Modifications

AEA states that benthic sampling was performed according to the study plan because a petit Ponar grab sampler was used in low velocity areas with fine substrate and a Hess sampler was used at higher velocity areas with coarser substrate. Due to rapid changes in flow and river stage, AEA states that there were difficulties in sampling where all substrates had been submerged for 30 days or more prior to sampling; however, AEA notes that the benthic community currently exists under such conditions, and sampling under these condition is representative of the benthic community of the Susitna River. AEA estimates that 24 percent of the sampling sites may have been dewatered at some point within 30 days of when the sample was collected.

AEA indicates that in mainstem macrohabitats, the Hess sampler was primarily used to sample shoreline areas that would be the most affected by the project's proposed peaking operations (i.e., daily fluctuations creating a varial zone). AEA contends that glacial melting under existing conditions already causes diurnal fluctuations in shoreline areas, so measuring the communities in these shoreline areas is needed to characterize the existing environment. AEA also contends that high turbidity levels in the mainstem macrohabitats prevents algal growth and macroinvertebrate colonization to a large degree. Measurements of light penetration revealed that light levels needed for photosynthesis rarely reached beyond a depth of 1 to 1.5 feet at mainstem sites.

AEA states that many of NMFS and FWS's suggestions for alternative techniques, while certainly possible, are logistically impractical for the Susitna River. Sampling devices that utilize nets such as kick nets are unable to exclude the high amounts of drifting material present in the mainstem macrohabitats from entering the net. AEA's experience with drift sampling in the main channels and side channels resulted in nets often clogging within 2 minutes of deployment. This clogging of the mesh net impedes further flow from entering the net, and results in potential losses of intended sample targets. Using open nets would also make it difficult to isolate drifting organisms and organic matter from benthic organisms and organic matter. AEA states that the advantage of the Hess sampler is that it isolates the sampling area, and keeps out drifting

materials. AEA states that there is also considerable difficulty and personal risk in conducting kick samples in depths exceeding 2.5 feet with higher velocities, as it is harder for personnel to maintain their balance and position while actively kicking in velocities exceeding 3 feet per second. AEA contends that the suggestion to employ sampling that is reliant on divers (e.g., dome samplers) is equally impractical, introducing logistical complications of requiring certified divers to collect samples in high velocities with zero visibility due to the high glacial turbidity in Susitna River. The logistics of utilizing an air-lift sampler are restrictive, as it would require a costly custom-fabricated sampling device and either an air compressor or tanks of compressed air that could only be operated on-board a highly maneuverable boat able to maintain a steady position in high velocity currents for the duration of collecting an individual sample in deep water locations.

As a result, AEA proposes to deploy six Hester-Dendy samplers at one main channel macrohabitat site at increasing depth increments to record the effects of stage change and exposures along the main channel's fluctuating shoreline. AEA plans to deploy the additional Hester-Dendy samplers for four to six weeks over the open water period during the next study season.

Discussion and Staff Recommendation

Based on our review of the study reports, AEA selected its sampling gear according to the methods specified in the approved study plan in that it deployed a petit Ponar grab sampler in lower velocity areas and a Hess sampler in higher velocity areas. Although the Hess samplers work well in shallow swift habitats, they are not well-suited for sampling deep and swift mainstem habitats. However, NMFS and FWS's recommended alternative sampling methods would not necessarily be any better suited for sampling these faster, deeper habitats because they are either ineffective (e.g., kick nets), impractical (e.g., airlift sampler), or would be difficult and dangerous to deploy (e.g., dome sampler) because they would require divers in the swift and turbid waters of the mainstem Susitna River.

As noted by AEA, shallow areas along the mainstem channel margins have the greatest light penetration for benthic algae and aquatic macrophyte production, especially in extremely turbid environments such as the mainstem Susitna River habitats, and would also be areas within the varial zone that would be most affected by the project's proposed peaking operations; therefore, it is reasonable to focus sampling in these locations in order to maximize data collection that is needed for our analysis of project effects (section 5.9(b)(4)). Additionally, based on our review of the study reports, AEA made a reasonable attempt to select sample sites that would not be dewatered within 30 days of sample collection. Although AEA reports that about 24 percent of the sites may not have met this goal, it would be nearly impossible to achieve a goal of 100 percent of sites not being dewatered within the 30 days due to the dynamic nature of Susitna River flows during the open-water season; therefore we do not recommend that AEA discard any

samples that did not meet this requirement. As indicated by AEA, the benthic community currently exists under such conditions, and using some samples that were collected under these condition would be useful to fully characterize the benthic community of the Susitna River (section 5.9(b)(4)). However, because the Hess samplers restricted sampling to habitats that were about 1-foot deep or less, we agree with NMFS and FWS that the data AEA has collected with the Hess samplers is inadequate to determine if deeper mainstem habitats are suitable for benthic macroinvertebrates and thus should be incorporated into macroinvertebrate HSC/HSI.

While AEA's proposal to deploy an array of six Hester-Dendy samplers at one main channel macrohabitat site at increasing depth increments during the next study season should provide some information to determine whether deeper water mainstem habitats are occupied by benthic macroinvertebrates, it is unlikely that such a small sample size will be sufficient to inform the development of macroinvertebrate HSC/HSI in deeper mainstem habitats, if in fact these deeper sites are occupied. Therefore, we recommend that AEA include in the USR a comparison between the data obtained from the deeper site to the data at the shallower sites (using both the prior Hess sample results and the new Hester-Dendy sample results). If the results of this comparison suggest that macroinvertebrates are occupying deeper mainstem habitats that were inadequately sampled using the Hess samplers, then AEA should also include in the USR any proposals for additional monitoring of deep-water mainstem sites (up to about 3 feet deep) at the other river productivity sampling stations using Hester-Dendy samplers. While we are not recommending at this time that AEA expand the deep water mainstem sampling to the other river productivity sampling stations during the next study season, we would have no objection to AEA completing such sampling now if it wishes to minimize the potential for having to complete the sampling after the USR is filed (if the results of our recommended comparison suggest that more deep water sampling is needed to develop benthic macroinvertebrate HSC/HSI).

In addition, because AEA does not specify the location where it will conduct the additional sampling, and site selection is important to ensure that the data are useful for their intended purpose of characterizing the benthic community at a range of depths up to about 3 feet deep, we also recommend that AEA consult with the TWG prior to selecting its proposed Hester-Dendy sample site for the next study season. This would be a low-cost (section 5.9(b)(7)) requirement that would enable the agencies to contribute their expertise in selecting an appropriate sample site.

Further, to provide information on the water depths and the extent to which each of the six samplers within the Hester-Dendy array remains wetted during the sampling period, we also recommend that AEA deploy a stage-recorder at the Hester-Dendy sample site to monitor water levels, and report on the duration and frequency each sampler was watered/dewatered during the proposed 4 to 6 week deployment period (section 5.9(b)(6)). We estimate that the costs of our additional recommended water-level monitoring and reporting will be $3,000 (section 5.9(b)(7)), and conclude that the information to be gained is needed to fully interpret the data that are collected.

Collection of Algal Samples from Fine Substrate Habitats

Requested Study Modifications

NMFS and FWS state that during the 2013 study year AEA chose to collect algae from cobble substrates in habitats dominated by fine sediment (e.g., mouths of upland sloughs, side sloughs, and tributary mouths), because cobble provides a more stable algal substrate for sampling. As a result, the agencies assert that AEA's decision to sample cobble substrate rather than fine sediment from benthic grab samples for algae may not be representative of the backwater habitats dominated by fine sediment nor support an evaluation of food resources among those habitats. As such, NFMS requests that AEA not use the data from algal samples collected from cobble substrate within macrohabitats dominated by fine sediment. Rather, NMFS and FWS request that AEA collect invertebrate and algal samples from those macrohabitats dominated by fine substrates as specified in the study plan. NMFS and FWS suggest chlorophyll-a can easily be extracted from sediment using the petri dish method or cores, and the sediment sample can be burned to estimate Ash Free Dry Mass (AFDM).[23]

Comments on Requested Study Modifications

AEA states it implemented data collection consistent with the study plan with the exception of collecting algae from coarse substrate only rather than fine substrate in backwater areas. AEA also states that the benthic grab sampler, although ideal for benthic macroinvertebrate sampling in fine sediment, is not suitable for the collection of algae because the surface of the sediment sample is disturbed when the sample is removed from the grab sampler. Therefore, AEA states that utilizing algae samples obtained from grab samples would have resulted in artificially high AFDM estimates due to organic matter other than periphyton present in the sample.

Discussion and Staff Recommendation

AEA was required to collect algal samples from fine sediment (silt and sand sized substrates) in low velocity areas at various water depths up to three feet using a grab sampler. However, AEA did not collect algal samples from these fine sediments because the grab sampler often broke the surface of the substrate; thereby, fouling the algal sample with organic matter from within the substrate. Instead, AEA elected to collect algal samples from coarse-grained substrate (cobble sized) and woody snags that were also present in the low velocity areas dominated by fine substrates. AEA noted this deviation from the study plan as a study variance.

[23] Ash free dry mass is a measure of biomass that entails drying samples to a constant weight, oxidizing (combusting) them in a furnace, and reweighing the oxidized samples. The loss in weight upon oxidization is the ash free dry mass (AFDM).

There is insufficient information available to determine whether the algal samples that AEA collected from cobble substrates and woody snags are a suitable surrogate for the samples that it proposed to collect from the dominate fine sediment substrates. Thus, more information is needed to determine whether the samples AEA collected are sufficient to meet the study objectives of characterizing the algal community with these depositional backwater habitats (section 5.9(b)(1)). Although we see no reason to discard the samples as the agencies recommend, we do recommend AEA collect a total of 15 algal samples from fine substrate and a total of 15 algal samples from coarse grained substrate in low velocity habitats from within three different sampling units (e.g., 5 samples from each substrate type (10 total) in three different macrohabitats) and compare chlorophyll-a concentrations and AFDM estimates between the two substrates to determine whether there are any meaningful differences in algal communities between the two substrate types. The results of the sampling and comparison between samples collected on both substrate types should be presented in the USR along with any proposals for additional algal sampling of fine sediments, if needed. Further, we recommend that AEA consult with the TWG to determine the most appropriate season and sampling device to collect algae samples for this comparison. This information is necessary to determine the suitability of the existing samples for characterizing the existing environment for benthic algae.

Collection of Algal Samples from Multiple Depths

Requested Study Modification

NMFS and FWS state that algal samples were not collected at depths of up to 3 feet, and not all main channel and side channel macrohabitats were inundated for 30 days prior to sampling, as required by the study plan. NMFS and FWS note that the study plan requires AEA to collect algal samples from multiple depths to determine the relationship between light availability and productivity, as well as provide data for HSC/HSI. NMFS and FWS request AEA collect algal samples at areas that have been inundated for at least 30 days and from multiple depth strata (0- to 1-foot, 1- to 2-feet, and 2- to 3-feet) within each macrohabitat and proportional to the depths present. NMFS and FWS also request that AEA not use, in subsequent analyses of chlorophyll-*a* and AFDM, values from previous samples collected from areas that were dewatered within the 30 days prior to sampling.

Comments on Requested Study Modification

AEA states that it sampled algae at the three depth strata specified in the study plan when they were available as required by the approved study plan, but that sampling at depths greater than two feet often placed field personnel at risk due to high water velocities. AEA also states that high turbidity within mainstem macrohabitats limits the amount of photosynthetic active radiation (PAR) that reaches the river's substrate, thus restricting algal and macroinvertebrate colonization in deeper habitats.

AEA states that it collected 1,770 substrate samples for algae in 2013. Sample depths ranged from 0.05 to 3.3 feet deep, with an overall average depth of about 0.6 foot. Approximately 84.5 percent of the substrates were collected at 0–1 foot, 14.3 percent at 1–2 feet, and 1.2 percent at 2–3 feet. AEA notes that FERC's study plan determination required that *"AEA should sample benthic algae on cobble substrates at multiple depths up to 3 feet (e.g., depth categories of 0–1 foot, 1–2 feet, and 2–3 feet) at each macrohabitat site (main channel, tributary confluences, side channels, and sloughs), to the extent feasible given the limits of field safety."* AEA argues that sampling in depths greater than 2 feet in main channel and side channel sites often put the crew at risk. To retrieve a cobble by hand (so that the periphyton on the rock surface would remain undisturbed) in depths of 2 feet would require complete submergence by the crew member, in velocities often exceeding 3 feet per second. These depths were often far out into the river, away from shore, the boat, and any tree or object to which to tether for safety.

Discussion and Staff Recommendation

AEA attempted to collect algal samples at the three depth increments to the extent feasible, but it was difficult to obtain samples from depths greater than 1 foot because high water velocities limited safe sampling at these sites. We agree with AEA that sampling at depths greater than 1 foot is a legitimate safety concern and neither agency provides any specific recommendations with respect to what additional sampling methods could be used to safely collect additional algal samples within these swift and turbid mainstem sampling sites. Although the proportion of algal samples collected within the deepest depth increment (i.e., greater than 2 feet) is low at 1.2 percent of the total number collected, we do not have good cause to conclude that AEA did not attempt to implement the study as required by the approved study plan which clearly states that AEA should attempt to sample at depths up to 3 feet to the extent feasible given the limits of field safety. Of the 1,770 samples collected thus far, AEA indicates that about 15.5 percent of these were collected in habitats between 1 and 3 feet deep. This is a sufficient sample size to determine if the deeper habitats that are difficult to sample are suitable for algae and should provide sufficient information to develop algal HSC/HSI.

Additionally, as we said above in our analysis and recommendations for *Sampling Depth for Benthic Communities in Main and Side Channel Habitats*, because of the dynamic nature of mainstem flow fluctuations during the open-water period, it is unreasonable to require AEA to meet a standard that 100 percent of sampling sites remained watered for 30 days prior to benthic sample collection. AEA made a reasonable attempt to collect samples from sites that remained watered for the 30-day period prior to collection; the data from these sites will be sufficient to meet the study objectives and inform our analysis (section 5.9(b)(4)). Therefore, we do not recommend that AEA discard any existing benthic algae samples or repeat the previous algal sampling in mainstem habitats as recommended by NMFS and FWS.

Seasonal Benthic and Algal Sampling Schedule

NMFS and FWS state that the 2013 benthic macroinvertebrate and algae sampling did not follow the schedule provided in the study plan because the late ice break-up followed by high temperatures in the spring delayed sampling until late June. The agencies also state that the delayed ice break-up constitutes anomalous environmental conditions pursuant to the Commission's regulations. NMFS and FWS also raise concerns associated with the timing of the spring sampling event, noting that sampling was conducted too late; therefore, the data are not representative of the targeted low turbidity spring conditions. They also note that the fall sampling event occurred too early because turbidity levels in the river were too high. NMFS and FWS request AEA collect again benthic macroinvertebrate and algae samples during the spring, summer, and fall sampling events, specified in the study plan, for a minimum of two additional years. To measure potential increases in primary production during the clear water spring and fall periods, the NMFS and FWS request that AEA perform the spring sampling prior to June 1 and the fall sampling in October.

Comments on Requested Study Modifications

AEA states that, given ice conditions and variability in the timing of peak glacial melt, sampling prior to June 1 and in October is not always practical in the Susitna River. The timing of ice breakup and ice cover development in the spring and fall, respectively, is unpredictable and changes occur rapidly. AEA states that it conducted sampling as early as possible during the open water period (spring), during the peak of the growing season (summer), and as late as possible during the open water period (fall). AEA notes that sampling prior to ice break up would pose logistic and safety challenges. In addition, AEA states the 2013 study season had an extremely late ice breakup followed by high temperatures in June, which caused very high flows and prevented it from commencing the spring sampling during the April to early June period as specified in the study plan.

AEA also states that the timing of fall sampling is always a concern due to the rapid formation of the ice cover. Based on timing of ice cover formation for the past three years, waiting until October to begin the fall sampling event would present sampling difficulties because freezing conditions and ice formation would likely compromise AEA's ability to complete sampling of all sites. AEA states that in October 2013, boat access to sampling locations was complicated by low flows and ice, and crews finished with the third sampling event just days before they pulled all boats from the river.

Discussion and Staff Recommendation

As discussed in our analysis for study 9.5, rapidly fluctuating environmental conditions will always be a factor in sampling a remote and extremely dynamic study environment such as the Susitna River. Therefore, we consider the sampling results from

the environmental conditions that occurred in spring and fall of 2013 to be valid and useful for our environmental analysis and the development of license requirements (section 5.9(b)(4)). Although AEA proposed to target its spring macroinvertebrate and algal sampling event during the period from April through early June, the late break-up and high flow event that occurred immediately thereafter during spring of 2013 prevented AEA from completing its first seasonal sampling event during this proposed period. However, AEA initiated its spring sampling event as soon as conditions allowed (beginning in late June). This early sampling event coupled with the summer and fall events during 2013 met the study objective of attempting to spread the sampling out over three distinct periods (i.e., spring, summer during the peak growing season, and fall prior to ice cover) and is sufficient information for our analysis (section 5.9(b)(4)). For these reasons, we do not recommend requiring AEA to complete an additional two years of sampling as recommended by NMFS and FWS.

Macroinvertebrate Emergence Sampling

Requested Study Modifications

NMFS and FWS state that sampling of macroinvertebrate emergence was not performed in accordance with the study plan because: (1) the emergence traps were not deployed in the spring prior to ice break-up, (2) the emergence traps were not emptied every two weeks, and (3) the emergence traps were deployed at locations not representative of the macrohabitats they were intended to sample. NMFS and FWS also note that many of the emergence traps were damaged or dewatered during deployment; therefore, differences among emergence timing or insect production among Focus Areas and macrohabitats cannot be evaluated. Thus, NMFS and FWS request AEA not use data from traps that were dewatered during the deployment period and repeat the emergence sampling among all macrohabitats, with a minimum of five traps equally distributed along a 200 or 500 meter sampling unit. NMFS and FWS also request AEA collect samples in the spring prior to ice break-up, to coincide with the emergence of juvenile salmon.

Comments on Requested Study Modifications

AEA disagrees with the recommended modifications. AEA acknowledges that there were issues with emergence trap sampling in 2013 primarily due to wildlife disturbing the traps and fluctuating river levels over the 2-week period between trap checks, but notes that the sampling is incomplete and it plans to complete a second year of emergence trapping as required by the approved study plan. AEA also states that it is proposing modifications to the sample design to improve the study results during the next study season. This includes deploying traps for a shorter duration (i.e., 24-48 hours), instead of 2 weeks, to minimize sample losses due to wildlife disturbance or sample unit dewatering. AEA also proposes to redesign the traps to prevent sinking. AEA acknowledges that it couldn't deploy traps in April 2013 prior to ice-out because there

was insufficient time (less than 30 days) after the Commission's April 1, 2013 study plan determination to mobilize for trap installation. However, AEA intends to install traps during this period during the next study season. AEA also indicates that deploying multiple traps at each site would be a useful modification.

Discussion and Staff Recommendation

AEA's proposed modifications will likely increase the usefulness of the data and should be sufficient to enable it to meet the study objectives (section 5.9(b)(1)). However, AEA does not specifically define how many traps it would deploy within each sampling unit. We agree that deploying multiple traps per sampling unit would increase the likelihood that the data would be useful should problems persist with trapping operations. However, we see no reason to specifically require that AEA deploy five traps per sampling unit or equally distribute the five traps within each 200 or 500 meter sampling unit as recommended by the agencies because there is no guarantee that placing five traps at randomly chosen locations that are equally distributed within a sampling unit would have suitable conditions for successful trap placement. Instead, AEA should determine the appropriate number and location of traps at each sampling unit based on site-specific conditions and take into consideration, among other things, whether the traps at each site are likely to be disturbed by wildlife or dewatered due to flow fluctuations.

Additionally, we see no reason to discard the sampling results from 2013 as recommended by NMFS and FWS. As noted by AEA, the 2013 results would, at a minimum, provide some useful qualitative information on insect emergence that could help meet the study objectives (section 5.9(b)(1)).

We also see no reason to require AEA to complete two additional years of emergence trapping. As we said, AEA already proposes an additional year of sampling with an improved sample design that should better enable it to meet the study objectives and provide sufficient information to inform our analysis (section 5.9(b)(4)).

Talkeetna River Reference Macrohabitats

Requested Study Modifications

NMFS and FWS state that AEA only collected benthic macroinvertebrate, invertebrate drift, algal, and benthic organic matter samples from three of five macrohabitat types (side channel, side slough, and upland slough) within the Talkeetna River reference site. Therefore, NMFS and FWS request that AEA also sample the two additional macrohabitats (main channel and tributary mouth) that AEA sampled for river productivity in the Susitna River in order to fully evaluate the suitability of the Talkeetna River as a reference site.

Comments on Requested Study Modifications

AEA states the objective of sampling in the Talkeetna River was to determine if the Talkeetna River would provide a valid reference site for monitoring long-term project related changes in benthic productivity during project operation. AEA states that the macrohabitats it elected to sample were chosen after consultation with the TWG as required by the approved study plan, and that the data it has collected from the three macrohabitats are sufficient to meet the study objective of determining whether the Talkeetna River is a suitable reference site for post-license monitoring, or if it should seek another reference site located elsewhere for this purpose.

Discussion and Staff Recommendation

We agree with AEA that the samples collected within three macrohabitats are a sufficient sample size to enable it to achieve the study objective (section 5.9(b)(1)) of comparing data collected within the Talkeetna River and the Susitna River to determine if the Talkeetna River is a suitable reference site for long-term post-license monitoring of changes in productivity in the Susitna River due to project operation. However, the Commission would typically evaluate and determine the need for such a long-term monitoring program,[24] after the license application is filed. If the Commission were to decide at that time that such long-term monitoring is in the public interest, then the appropriate time to collect any additional data needed for such a program would be after licensing when there would be ample time between license issuance and project construction and operation to do so. For these reasons, we do not recommend requiring AEA to complete any additional monitoring in the Talkeetna River or any other tributaries for the purposes of evaluating suitable reference sites for a future potential long-term post-license river productivity monitoring program.

Invertebrate Drift, Seasonal Diel Drift Sampling, Fish Growth Rates, and Bioenergetics Modeling

Requested Study Modifications

NMFS and FWS state that AEA sampled invertebrate drift at different times of day but only during daylight hours, and that it has been well established that invertebrate drift rates vary seasonally and over a 24-hour period. Thus, AEA's sampling likely missed key aspects of invertebrate drift relevant to fish diets. Therefore, NMFS and FWS request AEA conduct invertebrate drift sampling every four hours over a 24-hour period

[24] We are not aware of any project facilities that would be constructed in the Talkeetna River; therefore, any project effects on the Talkeetna River would be limited to a relatively short segment at the confluence with the Susitna River within the project's zone of hydrologic influence.

during the spring, summer, and fall seasons in one or more of each macrohabitat type to determine seasonal diel variation of invertebrate drift.

NMFS and FWS also state that main channel and side channel invertebrate drift samples were not collected according to the approved study plan because invertebrate drift samples were collected within the tributary and not downstream of the respective tributary mouth as specified. NMFS and FWS contend that tributary discharge was not measured so AEA cannot calculate drift flux and assess tributary influence on food availability in the mainstem.[25] Therefore, NMFS and FWS request that AEA measure invertebrate drift upstream and downstream from tributary mouths as specified in the study plan during the next year of study. Alternatively, if drift is to be measured upstream of the tributary and within the tributary, NMFS and FWS request that AEA measure tributary discharge in all tributaries where drift studies were performed.

NMFS and FWS state that the growth rate and bioenergetics modeling study components are inadequate and failed to meet the study objectives. Therefore, NMFS and FWS recommend the following modifications to the study plan to address the study insufficiencies:

(1) modify the study objectives to require the use of bioenergetics modeling to evaluate the pre- and post-project influence of temperature, water velocity, food availability, and food quality on juvenile coho and Chinook salmon at five or more replicate macrohabitats from within Focus Areas below Devils Canyon to take advantage of 2-D hydraulic modeling and to overlap with the distribution of juvenile salmon;

(2) conduct the study between July and early September to reduce effort and allow time for age-0 juvenile salmon to move from spawning to summer rearing locations, and for most age 1+ Chinook salmon to emigrate from the Middle River. Fish sampling must be conducted to provide a measure of relative abundance on each sampling date and at each sampling site;
(3) cold brand all Chinook and coho salmon captured on each sampling event with unique marks for sampling location and individuals to determine average growth within a site between sampling events and individual growth for recaptured fish;
(4) simultaneously conduct invertebrate drift sampling every other week throughout this time period; and
(5) coordinate this study with other studies to determine the number and locations of additional water temperature monitoring locations within each sampling site to provide accurate and representative values.

[25] Drift flux or drift rate is the product of drift concentration and discharge.

Comments on Requested Study Modifications

AEA states that macroinvertebrate drift sampling locations in 2013 and 2014 were established upstream of the tributaries and within the respective tributary delta. AEA states that it sampled within the tributary deltas to fulfill the study plan determination requirement that it sample invertebrate drift downstream of each tributary mouth. AEA states that sampling within the delta enabled it to meet the intent of the this requirement because it allowed it to determine the relative contribution of the invertebrate drift from the tributary to habitat downstream of the tributary by comparing the results of the tributary delta sampling with the results from upstream of the tributary mouth. AEA also states that discharge data are available for three tributaries studied in 2013 and five tributaries studied in 2014. AEA argues that any drifting invertebrates emanating from the tributary to the mainstem invariably would be captured within the tributary delta nets. All flow from the tributary extends downstream into the area known as the plume, before it begins to mix with mainstem waters. Establishing additional drift nets in this plume area would still sample the full drift content as in the delta, as the tributary outflow has not mixed yet with the turbid mainstem water. Differences in drift would only be apparent the farther downstream one sampled, due to dilution or dispersion, but AEA did not interpret that sampling far downstream within the mixing zone was the intent of the study plan determination.

With regard to diel invertebrate drift sampling, AEA states that diel sampling was not a part of the study plan. AEA also argues that diel variation in invertebrate drift is most prominent in the contiguous Unites States, and that the Alaskan photoperiod is significantly different with summers having little darkness and winters having few daylight hours, thus extinguishing the invertebrate drift rhythm. AEA also notes that chironomids, which comprised the majority of the drift collected, are usually aperiodic and do not demonstrate a diel drift pattern (Brittain and Eikeland, 1988).[26]

With regard to NMFS and FWS's recommended growth rate and bioenergetics modeling modifications, AEA disagrees with all of the requested study modifications and indicates that many of them appear to be a reiteration of the agencies' prior study requests and comments on the RSP that were already addressed in the Commission's April 1, 2013, study plan determination.

Discussion and Staff Recommendation

The components of study 9.8 addressed in this discussion pertain to the following specific study objectives as set forth in section 9.8.1 of the approved study plan:

[26] Chironomids are non-biting midges with global distribution of the family Chironomidae.

- estimate drift of benthic macroinvertebrates in selected habitats within the Middle and Lower River to assess food availability to juvenile and resident fishes,
- conduct a trophic analysis to describe the food web relationships within the current riverine community within the Middle and Lower River, and
- characterize the invertebrate compositions in the diets of representative fish species in relationship to their source (benthic or drift component).

To accomplish these objectives, the approved study plan required AEA to study through a variety of means, including field studies, resources such as invertebrate drift and fish growth in a variety of habitats in both the Middle and Lower River. The studies conducted by AEA and the associated study results presented in the ISR and other reports (e.g., study 9.8 SIR) show that AEA is on track to meet the study goals (section 5.9(b)(1)) and adequately estimate such factors as the level of macroinvertebrate drift and fish growth in a variety of habitats for use as part of our environmental analysis. There is no need for a more precise analysis as recommended by NMFS and FWS; therefore, we do not recommend modifying and expanding the study as recommended by NMFS and FWS.

Stable Isotope Analysis

Requested Study Modifications

NMFS and FWS recommend that AEA repeat the stable isotope component of this study because the level of sampling was inadequate to meet study objectives and sampling was conducted at locations that do not support salmon spawning. Therefore, NMFS and FWS recommend that AEA duplicate the study using data only collected at the following four Middle River Focus Areas: Indian River (FA-141), Gold Creek (FA-138), Skull Creek (FA-128), and Whiskers Creek (FA-104). The agencies note that the Skull Creek (FA-128) and Whiskers Creek (FA-104) Focus Areas would provide continuity with the 2013 – 2014 study data and the Skull Creek site also provides sockeye and chum salmon spawning and rearing habitat. NMFS and FWS also state that the approved study plan required AEA to consult with them on the stable isotope study site selection but AEA did not.

NMFS and FWS state that the ISR does not report the number of target fish species sampled, where those samples were collected, nor the number of samples collected for any insects, algae, or organic matter. Consequently, when repeating the study as they recommend, NMFS and FWS assert that AEA should collect a composite sample that consists of samples obtained from 10 or more locations that are systematically distributed 20 meters apart or randomly selected with each macrohabitat. NMFS and FWS also request the composite sample contain at least 10 grams of macroinvertebrates, 5 grams of algae, 5 grams terrestrial invertebrates, and 5 grams of benthic organic matter

Comments on Requested Study Modifications

AEA states their field efforts in 2013 and 2014 consisted of stable isotope sampling from four Focus Areas located from PRM 184 to PRM 81, which was two more than required by the approved study plan and therefore negated the need for agency consultation. AEA states that its sampling strategy provided data from a wide variety of macrohabitats, representing varying levels of marine-derived nutrients and facilitating a comparison of food web differences between areas with high and low densities of spawning salmon. In contrast, AEA claims that the sites recommended by NMFS and FWS would only sample areas with a high density of spawning salmon, which would not accomplish its objective of detecting whether there is a spatial gradient of marine derived nutrients along the Susitna River.

AEA states that it collected more than the number of samples specified in the study plan and that the samples were collected throughout each macrohabitat using Hess, Ponar, drift, and D-net samplers, and target sample weights were greater than what the agencies recommend.

Discussion and Staff Recommendation

The intent of study objective 5 is to investigate the contribution of marine-derived nutrients from spawning salmon to freshwater ecosystems. AEA will use the study results in conjunction with the bioenergetics model to further explain the energy source pathways and trophic relationships in the Susitna River food web. To complete this element of the study, the approved study plan required AEA to consult with the agencies and then select two Focus Areas within the Middle River for sample collection for stable isotope analysis. Nevertheless, due to a variety of reasons (notably that it expanded the required sampling from two to four study areas including both the Middle and Lower River, thus doubling the level of sampling effort), AEA did not consult with the agencies prior to selecting its study sites and instead selected and sampled available macrohabitats at one sampling station in the Lower River as well as at three Middle River Focus Areas.

As we said in our April 2013 study plan determination, the data generated from the stable isotope analysis component of the river productivity study has little bearing on the study as a whole and would not likely inform the development of license requirements. Thus, for our purposes, the stable isotope analysis would only be useful to provide baseline information on nutrients transported from the marine environment to freshwater habitats of the Susitna River. AEA's study efforts included sampling for marine derived nutrients beginning in the Lower River at Montana Creek and continuing along three Focus Areas distributed throughout the Middle River between Whiskers Slough near the Three Rivers Confluence Area upstream to the Watana Dam site. The study as implemented meets the intent of the approved study plan and is sufficient for describing how marine-derived nutrients are longitudinally distributed throughout the study area. Redoing the study within a relatively confined cluster of Middle River Focus Areas as recommended by NMFS and FWS to target areas with high salmon spawning

and rearing would bias the results and would not result in a better study outcome (section 5.9(b)(6)). In addition, as noted above, the data are not needed to inform our analysis or to develop license requirements (section 5.9(b)(4)); therefore, we see no reason to modify the study plan as recommended by NMFS and FWS.

Fish Diet Sampling

Requested Study Modifications

NMFS and FWS state that fish diet sampling was not performed according to the approved study plan because the samples were not collected within one week of the collection of benthic and macroinvertebrate drift samples. NMFS and FWS also state that AEA's level of effort was insufficient to characterize the invertebrate compositions in the diets of representative fish species in relationship to their source (benthic or drift component) because the sample size was likely too small (e.g., only 260 total stomach samples were collected in 2013 out of a potential of 1,920) and sampling efforts did not include some macrohabitats (e.g., very few fish captures were made at Focus Areas 173 and 184). Therefore, NMFS and FWS recommend AEA analyze diets from a minimum of eight fish with food in their stomachs for each fish species and life stage as provided for in the approved study plan.

NMFS adds that AEA's fish diet sample size sufficiency analysis does not demonstrate that contents from 8 stomachs adequately represent diet composition for each species by site and sample period for the 2013 data. The literature cited does not support this either. NMFS argues that AEA's analysis is flawed because the diminishing number of stomachs as sample size increases from one to eight creates an artificial decrease in the potential to observe new taxa, most likely artificially creating an asymptote well before it would occur in an adequate sample size. Therefore, NMFS and FWS request that AEA repeat the fish diet sample size sufficiency analysis by pooling stomach samples from all sites and that AEA perform an assessment of fish diet data from earlier studies to determine whether eight stomachs is an adequate sample size for each species, macrohabitat type, and sampling period to represent the diets of the target species.

Comments on Requested Study Modifications

AEA believes that if all sampling events were pooled, this would indeed probably result in a plateau occurring at greater than eight samples. AEA states that this would be expected since the pooled sampling events would include a greater diversity of habitat types, seasons, and Focus Areas, and thus a greater diversity of available prey items. AEA argues that this would not address the question of whether the study adequately achieved the objectives because the study objectives were to address the broad spatial and temporal patterns of energy flow, not a comprehensive diet analysis at every site during every season. AEA agrees that sample sizes were insufficient for some sampling events

in 2013; however, the goals of the study were met, given the additional increased effort and sample numbers collected in 2014.

Discussion and Staff Recommendation

The approved study plan requires AEA to investigate the trophic relationship between fish and their benthic and terrestrial food sources by conducting a fish gut analysis of juvenile coho salmon, juvenile Chinook salmon, and juvenile and adult rainbow trout and comparing the results to collected drift and benthic macroinvertebrate data through a bioenergetics model. Fish collection sites are to correspond to all sites within the study stations to allow for comparison with the benthic macroinvertebrate community and drift compositions. The approved study plan requires AEA to collect stomach samples containing food from eight fish of each target species and life stage from each macrohabitat.

In 2013, AEA sampled gut contents of 1,920 fish, most of which were empty. To examine the sufficiency of the sample size, AEA completed a diet sufficiency analysis, which confirmed that collecting contents from eight stomachs with prey would adequately characterize the diversity of prey for each species and life stage in each macrohabitat. Having fallen short of the desired sample size, AEA collected gut contents again in 2014. Between 2013 and 2014, AEA sampled all the required macrohabitats, obtaining 195 non-empty stomachs in 2013 and 300 non-empty stomachs in 2014.

We do not recommend AEA redo its sample size sufficiency analysis by pooling all the collected samples as requested by NMFS and FWS because doing so would likely over-estimate the number of prey items that actually exist within the macrohabitats, and therefore is not accepted practice (section 5.9(b)(6)). Although AEA did not collect its target of eight non-empty stomach samples for all species and life stages and macrohabitats (notably rainbow trout), rainbow trout appear to be low in abundance throughout the study area and it would be difficult and costly (a minimum of $50,000 to $100,000) to devote dedicated sampling effort to specifically target this species and achieve the sample targets for both juvenile and adult life stages within multiple macrohabitats (section 5.9(b)(7)). This study component was designed to quantify broad seasonal and spatial patterns in aquatic, terrestrial, and marine-derived energy flow, and we find that the information collected thus far is sufficient to meet this study goal (section 5.9(b)(1)); therefore, we do not recommend modifying and expanding the study as recommended by NMFS and FWS.

Geographic Scope

Requested Study Modifications

The geographic scope of study 9.8 is the Middle River below the proposed Watana Dam site to the Lower River at Montana Creek. NFMS and FWS recommend extending the study reach all the way downstream to Cook Inlet to inform potential project effects

on nutrients, algae, and invertebrates that would subsequently affect fish distribution, run timing, and relative abundance of Pacific salmon, as well as eulachon and beluga whale and inform the development of measures to protect these resources. NMFS and FWS request that AEA consult with licensing participants to determine appropriate sample locations within their recommended expanded study area.

Comments on Requested Study Modifications

AEA states it established a Lower River study station at Montana Creek (PRM 81) that will support an evaluation of potential project effects in the Lower River, as well as any influence that the Chulitna and Talkeetna Rivers may have there. AEA notes the preliminary flow routing model results indicate that post-project average daily flow fluctuations in the Lower River would be less than existing daily average under current conditions.

Discussion and Staff Recommendations

We see no reason to require AEA to extend this study below Montana Creek at this time. At this point, the study is incomplete and ongoing and there is insufficient information to determine the magnitude of change to river productivity in the Lower River due to project operations. We will review the updated study and model results for all studies in the USR and determine if the then existing information is sufficient to inform our analysis of project effects on river productivity in the Lower River (section 5.9(b)(4)).

Study 9.9 – Characterization and Mapping of Aquatic Habitats

Background

Study objectives are to characterize and map Upper River tributary and lake habitats and Upper, Middle, and Lower River mainstem habitats for the purpose of evaluating the potential loss or gain in available fluvial habitat from project construction and/or operation and to inform other studies as appropriate. All habitats were mapped in accordance with the study plan; therefore, AEA considers the study complete.

Upper River Habitat Classification Documentation

Requested Study Modifications

NMFS and FWS recommend that the Upper River habitat classification results be provided in a single document. NMFS and FWS contend that the Upper River tributary classification results are not included in the ISR or SCR, but refers the reader to technical memoranda and appendices in other study plans for information. The agencies state that this information is necessary to ensure all information provided is current and includes

any study modifications or additional analyses recommended by the TWG or the Commission.

Comments on Requested Study Modifications

AEA states that the SCR includes all results of study 9.9 that are pertinent to study objectives, with previous reports referenced to integrate all study products. AEA asserts that presenting the study results differently is not necessary to meet the study objectives.

Discussion and Staff Recommendation

The Upper River tributary classification results are presented in the SCR. Habitat composition and descriptive summary statistics for all habitat metrics by mesohabitat within the Upper River tributaries are presented in tables 5.1-1 through 5.1-18. With the exception of the *Upper River Tributary Habitat within the Reservoir* discussed below, the information provided in these 18 tables is sufficient to meet the objectives of study 9.9. Additionally, with the exception of a table summarizing the distribution of habitat types within the proposed reservoir and upstream of the maximum pool elevation as discussed below, the study results discussed above are available (section 5.9(b)(4)), satisfy the study objectives (section 5.9(b)(1)), and provide the information required for our analysis and the development of any license requirements (section 5.9(b)(4)); therefore, we do not recommend that AEA be required to develop a single document compiling the Upper River habitat classification results.

Tables Summarizing Reach and Channel Characteristics of Upper River Tributaries

Requested Study Modifications

NMFS and FWS recommend that results be provided in a table for each Upper River tributary that show the starting and ending elevation of each geomorphic reach, reach slope, confinement, channel width, substrate, and other habitat variables. They contend that information on each geomorphic reach will provide them with the ability to determine if habitat and fish distributions are similar among geomorphic reaches with the same physical characteristics within a stream and among streams.

Comments on Requested Study Modifications

Recognizing the value of understanding the geomorphic reach attributes for Upper River tributaries, AEA states that it provided in attachment 9 of its ISR reply comments (R2 Resource Consultants, Inc. 2016) a summary of map-based geomorphic reach attributes that include tributary river mile, elevation, confinement, and reach scale gradient. However, AEA states that it is not practical to consolidate reach-wide geomorphic attributes with local attributes as requested by the agencies and notes that the requested modification is not necessary to meet study objectives.

Discussion and Staff Recommendation

While the information requested by NMFS and FWS is not compiled in a format preferred by the agencies, the requested information is available in table 9-3 and SCR tables 5.1-1 through 5.1-18. Table 9-3 reports reach-wide characteristics, including slope, starting and ending elevations, and confinement. Local reach attribute data is provided in the SCR in tables 5.1-1 through 5.1-18, which include habitat composition, percent gradient, mean bankfull width and depth, wetted width, erosion, substrate composition, instream cover, and riparian cover. Therefore, study results meet the information needs of the study (sections 5.9(b)(4) and (7)), and, except as discussed in the following section, are adequate for analysis and development of potential license requirements. Consequently, it is not necessary to consolidate reach-wide geomorphic attributes with local attributes.

Upper River Tributaries Habitat within the Reservoir

Requested Study Modifications

NMFS and FWS request that study results for Upper River tributaries be presented to show the relative distribution of habitats below the reservoir's inundation zone, within the reservoir's fluctuation zone, and above the maximum pool elevation. NMFS and FWS assert that Upper River tributary classification should include all tributary habitats, at all classification levels that would be directly altered by the proposed project. NMFS and FWS state that it is important to understand the geomorphic reaches and tributary mesohabitats that would be lost because of inundation and to be able to compare these habitats with tributary habitats projected to be above the maximum pool elevation. These results, along with fish habitat associations for each tributary from study 9.5, will be used to estimate project effects on the fish community, assuming ecologically relevant fish habitat models are constructed.

Comments on Requested Study Modifications

AEA states that it is not necessary to summarize survey data differently to meet the objectives of study 9.9. AEA asserts that it presents all tributary habitat data with respect to tributary geomorphic reach, consistent with the study objectives and study design. Further, its data presentation summarizes aquatic habitat data at a functionally relevant and meaningful scale. AEA notes that data collection locations are publicly available on the project webpage, and all baseline data are spatially referenced. Therefore, GIS can be used to evaluate the relative distribution of habitats within the inundation zone, within the fluctuation zone, and upstream of the maximum pool elevation. AEA asserts that collection of baseline data has been completed according to the study plan, and that a summary of baseline data in relation to project features is beyond the scope of study objectives.

Discussion and Staff Recommendation

Contrary to AEA's assertion, it is not clear what types or proportion of the Upper River tributary habitats may be affected by the proposed reservoir. Our review of the GIS files provided online found that they do not clearly delineate the Upper River tributary habitat types that occur within the two zones of the reservoir (i.e., below minimum pool elevation and within the reservoir fluctuation zone) or the habitat types that occur upstream of the maximum pool elevation. To evaluate the potential loss or gain in available fluvial habitat from dam construction, inundation, and project operations as specified under study objective 1, the relative distribution of Upper River tributary habitat should be reported based on elevation relative to pertinent reservoir elevations (section 5.9(b)(6)). Therefore, we recommend AEA provide a table in the USR that summarizes the proportion of Upper River tributary habitat types that occurs within the two zones of the reservoir (i.e., below minimum pool elevation and within the reservoir fluctuation zone) and the habitat types that occur upstream of the maximum pool elevation to clearly describe baseline conditions. While this recommendation will result in some additional analysis and associated costs to AEA, no additional field work or studies are anticipated (section 5.9(b)(7)).

Review and Ground-truthing of Aerial Imagery for the Middle and Upper River

Requested Study Modifications

NMFS and FWS request that AEA review the aerial videography for the Middle and Upper River and accurately and consistently classify the Level 3 macrohabitats and Level 4 mesohabitats for the main channel and visible off-channel habitats, using the classification definitions or criteria provided in the approved study plan. To classify the macrohabitats that cannot be definitively identified from aerial videography, NMFS and FWS recommend ground surveys be conducted and specify that they be conducted when flows are similar in magnitude to those captured in the aerial videography. NMFS and FWS argue that AEA did not follow required mapping protocols, and that its mapping efforts resulted in misclassified or incorrectly classified meso- and microhabitats. NMFS and FWS state that based on their review of AEA's 2012 aerial imagery, AEA's habitat classification in the SCR is largely inaccurate, inconsistent, and incomplete.

NFMS and FWS provide examples of problems to support their recommendation, including that AEA's ground truthing of macro- and mesohabitats resulted in the reclassification of six macrohabitats. Because only a portion of the sampled locations were ground-truthed, the agencies are concerned that the number of discrepancies (6 out of 192) is likely to be much higher.

Comments on Requested Study Modifications

AEA asserts that variability between habitat classifications and aerial imagery results from the dynamic conditions in the Susitna River that cause aquatic habitats to

vary on daily, seasonal, and annual scales. AEA indicates that habitat sizes and shapes change as they are inundated and dewatered by flow changes while being altered by episodic events, including floods, ice processes, riparian vegetation, and beavers. AEA asserts that while alternative methods may generate different results, the methods it followed are consistent with the approved study plan and support both of the study's sub-objectives: (1) to provide a baseline for future analysis of impacts of the project; and (2) to provide data to inform the suite of coordinated aquatics studies. AEA points out that the 6 out of 192 classifications in the Middle River that were revised with ground data indicates a relatively low (3 percent) uncertainty in AEA's habitat classifications.

Discussion and Staff Recommendation

In accordance with the approved study plan, AEA mapped aquatic habitats using high-resolution aerial photographs and aerial video. AEA completed ground-truthing surveys in mainstem habitats of the Upper River and Middle River, which included 100 percent coverage of mesohabitat mapping within Focus Areas. Within the 52 Upper River macrohabitat comparisons, ground truthing resulted in a different habitat classification than the aerial imagery results in only two instances. Within the Middle River, 6 out of 192 macrohabitat comparisons resulted in a different habitat classification. In each of these eight cases, aerial imagery results that originally classified habitats as side channels were reclassified as side sloughs. We consider these discrepancies to be limited and reasonably likely to occur given the Susitna River's dynamic channel.

With the exception of additional clarifications regarding how AEA classified some non-conforming split main channel habitats and ephemeral bar dissection channels discussed below, we find that the information collected by AEA and the habitat classifications provided meet the study objectives and are adequate for our environmental analysis and would inform the development of potential license requirements (section 5.9(b)(4)). Therefore, we do not recommend AEA reclassify aquatic habitats using aerial videography or conduct additional ground-truthing as requested by NMFS and FWS.

Reclassify Macrohabitats

Requested Study Modifications

NMFS and FWS argue that tributary mouth macrohabitats were misclassified based on the presence of clear water plumes at locations where tributaries entered the mainstem. They contend that the study should have identified all tributary mouth macrohabitats as tributaries that contain a clear water plume mesohabitat; however, NMFS and FWS found several locations where clear water plume mesohabitat was identified but the associated tributary mouth macrohabitat was not. In addition, NMFS and FWS argue that split channels were misclassified at locations that appear to carry subdominant flow (10 percent or less) and the channel is separated by islands with permanent vegetation. Finally, NMFS and FWS argue that side sloughs were also

misclassified based on the upstream connection to the main channel or water turbidity. Therefore, NMFS and FWS request AEA review the aerial videography for the Middle and Upper River and accurately and consistently classify the Level 3 macrohabitats and Level 4 mesohabitats for the main channel and visible off-channel habitats, using the classification definitions or criteria provided for in the approved study plan. Ground surveys need to be conducted at survey flows to classify those macrohabitats that cannot be definitively identified from aerial videography.

Comments on Requested Study Modifications

AEA states that it primarily used *orthoimagery* not video to map aquatic habitats and that it supplemented that data with information from video mapping to generate the line maps. AEA states that the NMFS and FWS's analysis appears to have relied on videography to evaluate AEA's classifications, which were made using aerial imagery collected at different flows, and then concluded that AEA's habitat classifications were incorrect. AEA states that because of the flow dependent nature of many features (e.g., clear water plumes and side sloughs), it is not surprising that one may detect differences in habitat classifications when using images collected under different flow conditions. AEA asserts that habitat classification was conducted according to the approved study plan and provides the reasoning below for the discrepancies identified by NMFS and FWS.

AEA states that the approved study plan does not define tributary mouth macrohabitat as including clear water plume mesohabitat. Instead clear water plumes are categorized within main channel macrohabitat habitat. AEA also states that although split channels generally had flows greater than 10 percent of the total flow, multi-split channels could have a smaller flow percentage in each channel, which is consistent with the classification used in the 1980s. AEA states that island vegetation criteria for split channel habitat was met because it included both perennial and woody vegetation being present in ether aerial video or aerial imagery. AEA states that the flow-dependent nature of the distinction between side channel and side slough explains the apparent discrepancies between the review of aerial imagery and NMFS and FWS' use of videography. Therefore, AEA finds that the differences in habitat classifications are not surprising and do not indicate inconsistencies.

Discussion and Staff Recommendation

As discussed above, our review of the habitat maps provided in appendix A of the SCR found habitats generally fit the criteria specified in the approved study plan. However, we do agree with NMFS and FWS that some channel habitats classified as split main channels do not conform to the definition approved in the study plan and it is unclear what definition AEA applied to these areas. The study plan defines split main channel as channels separated by bars or islands that are barren or support only annual vegetation. However, in some instances, AEA demarcated some channels as split main

channels even though they were separated by heavily vegetated islands with mature conifers. Given the presence of established vegetation on the islands between these channels, they did not meet the definition established in the study plan for the split main channel habitat classification. However, we also note that these channel habitats could not alternatively be classified as a side channel habitat because they carried more than 10 percent of the Susitna River flow.[27] As a result, we conclude that these channel habitats do not fit any of the pre-conceived channel habitat definitions developed for study 9.9. Therefore, we recommend that AEA clearly identify these problem areas in the USR and clearly explain how it mapped macrohabitats where two or more channels carrying significant flow (>10 percent) are separated by islands with established, long-lived vegetation (e.g., mature conifers). We note that for fish distribution and abundance studies (9.5 and 9.6), differences in how spilt main channels are characterized are not a problem because fish are not expected to use these habitat differently; therefore, AEA and the stakeholders have agreed to combine split main, multiple split main, and main channel habitats into one category—main channel habitat. Providing the recommended information would allow AEA and stakeholders to determine if similar steps could be done for other related studies. This information is needed to support our environmental review and inform the development of potential license requirements (section 5.9(b)(4)). Because this only requires updating the definition or providing clarification on the method used, the cost should be minimal (section 5.9(b)(7)).

Classification of Ephemeral Bar Dissection Channels

Requested Study Modifications

NMFS and FWS indicate that AEA's final line maps classify "ephemeral bar dissection channels"[28] as side channels, side sloughs, or upland sloughs and assert that these channels do not fit these habitat definitions because they are separated by an island

[27] Side channels are given two definitions in the final study plan (August 2013), and a third definition is provided in the SCR (October 2015). In the final study plan, they are first 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." Then side channels are defined in table 9.9-5 as a main channel habitat "that is turbid and connected to the active main channel but represents non-dominant proportion of flow." The SCR further refines the definition stating that side channels were identified in locations "completely inundated with turbid water (or contained portions that held turbid water), connected at both upstream and downstream ends to the main channel, and flowing around a permanently vegetated island and carried less than 10 percent of the main channel flow."

[28] The modification request uses the following terms interchangeably: "ephemeral flood channels (cross-island channels)," "ephemeral bar-dissection (flood) channels," "cross-island channels," and "flood channels."

without vegetation or by an island that does not meet the length criteria (at least as large as the bankfull channel width). NMFS and FWS contend that these channels should not be used to address study objectives or to inform studies 9.6 and 9.8 unless they are given a distinct classification because they arguably do not provide the same quantity and quality of fish habitat as similarly classified channels occupying the margins of the floodplain.

Comments on Requested Study Modifications

AEA states that the habitat classification hierarchy was applied as required by the April 1, 2013 SPD. It contends that the locations the agencies reference were appropriately classified as side channel or slough based on their connectivity to the main channel. AEA states that mid-channel features should be mapped and included in studies of aquatic resources because they are likely to be affected by the proposed project. Further, AEA asserts that giving ephemeral flood channels a distinct habitat classification is not necessary to meet study objectives or to provide a baseline for future analysis of impacts of the project, nor is it necessary to support coordinated aquatics studies.

Discussion and Staff Recommendation

Because NMFS, FWS, and AEA use a variety of terms to describe the channels in questions, it is not clear to us exactly which features NMFS, FWS, and AEA are discussing. We assume they are referring to channels that cross through loose sediment deposits (e.g., gravel bars) that appear as islands within the main channel during low-flow conditions.

Using this definition, we identified four locations with ephemeral bar dissection channels. All four locations are where the Susitna River meets the Chulitna River (see map 55 in appendix A of the SCR). Of these four locations, all were classified as side channels. While we recognize that these ephemeral bar dissection channels may provide some habitat under certain high flow conditions, these channels would not provide any aquatic habitat under typical flow conditions. Therefore, we agree with NMFS and FWS and recommend that AEA not use ephemeral bar dissection channel habitat data to inform studies 9.6 and 9.8. Because these features are rare and restricted to one location in the study area, omitting these data from those studies is not expected to negatively affect the study results or objectives. We recommend that the associated maps be revised accordingly to remove these habitat types. Given the limited nature of the change, we anticipate the cost of incorporating these modifications in the USR to be minor (section 5.9(b)(7)).

Mesohabitat Classification for Susitna River Habitats

Requested Study Modifications

NMFS and FWS assert that AEA does not accurately and consistently classify main channel and off-channel mesohabitats and that the remote line maps in the SCR do not accurately classify or differentiate between runs, glides, or backwaters. For example, in table 4.1.1 in the SCR, main channel habitats are classified as "Run/Glide"; however, "run" and "glide" are two distinct mesohabitat classification. As a result, NMFS and FWS recommend that AEA clearly define and accurately apply the mesohabitat classifications to Susitna River habitats.

In addition, NMFS and FWS point out that mesohabitat classifications are also used in study 9.6. These classifications are used to identify run habitat within beaver complexes and classify runs and glides interchangeably. NMFS and FWS assert that habitat inaccuracies noted in study 9.6 could be partly due to the inaccuracies noted in the remote line maps and ground surveys. Therefore, NMFS and FWS assert that if AEA's selection of study 9.6 survey locations, summaries, and analyses are to be conducted at the mesohabitat level, then AEA's mesohabitat classification must be completed at each main and off-channel habitat in the middle and upper segments of the Susitna River and not just a subset.

Comments on Requested Study Modifications

AEA states that remote imagery was used to classify main channel mesohabitats in the Upper and Middle River, but that it cannot be used to comprehensively characterize off-channel habitats at the mesohabitat scale because of the size of off-channel habitats and the extent of riparian vegetation cover. AEA states that while it is theoretically possible to classify off-channel mesohabitats using ground surveys, it is impractical to survey all of these off-channel habitats on the ground given the extensive study area.

With regard to the habitat classifications used in study 9.6, AEA contends that because of the extent of seasonal sampling and the range of flow conditions encountered under study 9.6, mesohabitat types often changed among sampling events and were not based on the snapshot characterization made in study 9.9.

Discussion and Staff Recommendation

AEA classified mesohabitats for all main channel habitats in the middle and upper segments and in a subset of off-channel habitats where ground mapping efforts were conducted as required by the approved study plan. The mesohabitat classifications are clearly defined in table 9.9-4 of the approved study plan, and these definitions were generally applied accurately to main channel and off-channel habitats of the Susitna River, with one exception—the designation of "Run/Glide" habitats.

AEA provides separate definitions for run and glide habitats and reports habitat attributes separately for these two classifications in the ISR; however, the habitats are grouped as "Run/Glide" in the SCR. Although the SCR mentions the challenge in differentiating run and glide habitats from remote imagery and aerial photos, the SCR never states that AEA would group these two habitat classifications nor did AEA explain what, if any, criteria were used when deciding to combine them. As a result, we recommend that AEA report run and glide habitats separately, if possible, provide the criteria used to combine them and a definition for the "Run/Glide" habitat designation in the USR. With this clarification, there would be no need to survey each off-channel and main channel mesohabitats to reclassify these macrohabitat types.

With regard to NMFS and FWS's request that AEA classify each off-channel habitat mesohabitat in support of study 9.6, we find this request to be unnecessary. While we concur that aerial mapping of off-channel habitats is not feasible because of the thick canopy cover and the extensive network of off-channel areas, the subset of locations ground mapped by AEA provide a representative sample of these off-channel habitats. This is consistent with accepted practices in hydrolicensing and is sufficient to support the selection of study 9.6 survey sites, analysis, and fish habitat association summaries (sections 5.9(b)(4) and (6)). Therefore, no additional field work is necessary and providing the additional information requested above would only marginally increase study costs (section 5.9(b)(7)).

Tables Showing Lengths on Line Maps for Susitna River Macrohabitats

Requested Study Modifications

NMFS and FWS state that AEA does not provide tables that can be used to summarize habitat at all five habitat classification levels, or that if these table are available, they are not electronically referenced, as specified in the study plan. NMFS and FWS request that AEA provide the results of the mainstem classification in tables showing the lengths of each line on the line maps for all mainstem macrohabitats (main channel and off-channel). Specifically, the RSP states that, "The GIS database will create a hierarchical table that will be used to summarize the proportion of habitat by mapped unit of length (Tables 9.9-6 and 9.9-7). The tiered approach will allow for summaries at all five levels to support resource study planning. The table would also provide individual identification of all unique habitat types."

Comments on Requested Study Modifications

AEA states that the GIS database described in the RSP was provided to all licensing participants via AEA's public webpage. AEA indicates that the GIS line length for each feature is provided in the GIS attribute table as documented in the metadata file that is also provided on its webpage. AEA asserts that the habitat data supporting the line mapping are extensive and not amenable to presentation in flat tables because of their

large size. In addition, AEA asserts that presenting the data in a different way will not improve its ability to meet the objectives of study 9.9. AEA notes that the GIS database allows any user to summarize classifications at Levels 1 through 4, as well as to review each individual line segment. It is AEA's position that the GIS database is the most straightforward way to link line segments and maps with their associated attributes and survey data.

Discussion and Staff Recommendation

Hierarchical tables summarizing habitat at all five habitat classification levels are needed to support a full assessment of baseline conditions in the study area. The link to the GIS database provided by AEA in its reply comments is not a substitute for clearly summarized tables. We agree with AEA's assertion that the GIS data set is large; however, this issue was anticipated early in the pre-filing process and is also the reason why more simple and "flat" tables are required in the approved study plan (see tables 9.9-6 and 9.9-7). The tables clearly specified in the approved study plan are not provided in the ISR or SCR, and this GIS information as it stands is too large to support our analysis and development of license requirements (section 5.9(b)(4)). Hierarchical table(s) that summarize the proportion of habitat by mapped unit of length will clearly describe baseline conditions. Therefore, we recommend that AEA provide the hierarchical tables required by the approved study plan in the USR. The tables must summarize the proportion of habitat by mapped unit of length as shown in tables 9.9-6 and 9.9-7 of the approved study plan. Because this information was previously required by the approved study plan, we do not anticipate any additional costs associated with the fulfillment of this recommendation (section 5.9(b)(7)).

Upper River and Middle River Macrohabitat Area Tables

Requested Study Modifications

NMFS and FWS state that AEA does not provide area maps showing each macrohabitat or tables of macrohabitat area for off-channel slough habitat. They assert that this information is necessary to determine the representativeness of Focus Areas and to evaluate sampling unit selection for studies 9.5 and 9.8. NMFS and FWS contend that the approved study plan methods were not applied because off-channel slough habitat in the Middle River was not mapped and drawn separately in an area (polygon), which hindered characterization of slough diversity needed for study 8.5. NMFS and FWS further state that maps showing the area of each macrohabitat or tables of macrohabitat area have not been provided as required by the approved study plan. NMFS and FWS, therefore, request that AEA provide maps and tables showing Upper and Middle River macrohabitat areas.

Comments on Requested Study Modifications

AEA asserts that additional calculations of habitat area are not necessary to meet study 9.9 objectives and notes that NMFS and FWS include an incomplete citation from the approved study plan to justify their request for area mapping of all off-channel habitats under study 9.9. AEA states that the language included in the RSP was intended to differentiate the line mapping in study 9.9 from the study's (study 8.5) conversion of macrohabitat from a linear to an area basis within Focus Areas. While NMFS and FWS suggest that off-channel area maps are needed to evaluate the representativeness of Focus Areas and evaluate flow-based changes in off-channel habitat area, AEA argues that these objectives are beyond the objectives of study 9.9 and instead fall under study 8.5, which is expressly designed to evaluate the impact of flow and stage changes on fish habitat quantity and quality.

Discussion and Staff Recommendation

Area mapping of off-channel slough habitat is needed to characterize slough diversity within the Middle River, determine the representativeness of Focus Area, and evaluate the potential change in available river habitat below the proposed dam through other studies (section 5.9(b)(4)). The approved study plan requires that: "All habitat segments will be identified using a mid-channel line, which will provide habitat length; however, off-channel slough habitat will be drawn separately in an area (polygon) in the Middle River to identify the size of each slough and better characterize slough diversity for study 8.5. Area mapping will be reported separately from the linear database." Although the assessment of slough diversity is ongoing and area maps have yet to be provided, information on the size and characteristics of slough habitat is important for meeting study objectives. The RSP (section 9.9.5.9) specifically states that "all relevant collected data from other studies will be reviewed and assessed to determine if updating or modifying the habitat mapping database with the additional and relevant information from other studies will be beneficial and supportive to the overall study goals." Therefore, consistent with the approved study plan, we recommend that AEA report the information requested by the agencies as part of study 9.9 (section 5.9(b)(6)). AEA estimates the costs associated with providing this information to be $45,000 (section 5.9(b)(7)).

Middle River Classification Maps – Beaver Pond and Backwater Mesohabitats

Requested Study Modifications

NMFS and FWS recommend that beaver pond complex and backwater mesohabitats be shown on classification maps for the entire Middle River and not just when they occur in Focus Areas. NMFS and FWS note that beaver dam complexes and backwaters are to be selected for study 9.6 sampling from both inside and outside Focus Area, which underscores the importance of including these features on the habitat maps.

Furthermore, NMFS and FWS state that because beaver dam complexes and backwaters are visible and were largely classified from aerial imagery, they could have been shown throughout the Middle River on habitat maps. NMFS and FWS note that these features are shown on previous maps where they occurred in off-channel habitats in and outside Focus Areas (ISR, appendix A, June 2014), which indicates it is feasible to do so. However, AEA only shows beaver pond complexes and backwaters in the detailed mesohabitat maps of Focus Areas (SCR, appendix B, October 2015) and not where they occur throughout the Middle River (SCR, appendix A).

Comments on Requested Study Modifications

AEA states that the beaver complex/pond and backwater features (Level 4 mesohabitats) are currently shown on all ground survey maps in accordance with the approved study methods and include locations where the ground surveys were completed both in and outside Focus Areas (study 9.9 SCR, appendix B). AEA clarifies that FDA sampling did not use beaver dam complexes as a unit of selection. Rather, study 9.6 characterizes slough macrohabitats as either beaver-influenced or not. AEA states that beaver-influenced sloughs are defined as sloughs in which any beaver activity was documented in the remote line mapping. AEA notes that this level of stratification has since been abandoned in the FDA studies because ground surveys have identified beaver influence in nearly all surveyed sloughs.

Discussion and Staff Recommendation

AEA classified beaver dam complexes and backwaters based on aerial imagery for the entire Middle River segment and provided the results on the remote line maps that it produced in 2012 and filed with the ISR in 2014. During the 2013 and 2014 field seasons, AEA conducted ground surveys to ground truth a subset of the Middle River habitat classification efforts within all Middle River Focus Areas and in other selected off-channel and main channel habitats outside of Focus Areas, as required by the approved study plan. The results of the ground truthing effort provided more information on the presence of beaver dam complexes and backwaters and were presented in the 2015 SCR as a different set of maps. NMFS's and FWS's request does not dispute the adequacy of this data, request additional data, or raise concerns about AEA's data collection efforts. Instead, they are simply asking AEA to repackage existing data by combining the two different sets of maps and presenting the two data sets as one. Consequently, the request would not provide any new information to help address the stated information needs of the study; therefore, the cost of implementing the request is not justified (section 5.9(b)(7)).

Expand the Geographic Scope

Requested Study Modifications

NMFS recommends expanding the geographic scope of the videography and remote line mapping effort of this study from the Yentna River confluence (PRM 32.3) to the Cook Inlet (PRM 3.3).[29] NMFS states that based on preliminary results from the open water flow model, there may be significant stage change and daily fluctuation mid-winter within the lowest 30 miles of the Susitna River. As a result, NMFS asserts that extending the geographic scope of study 9.9 and surveying the Lower River lateral and off-channel habitats will help describe the effects of Susitna-Watana dam.

Comments on Requested Study Modifications

Based on the results of hydraulic modeling, AEA agrees that project-induced changes in surface water elevation may affect lateral and off-channel habitats down to PRM 29. Therefore, AEA proposes to extend habitat characterization ground surveys (using tier I and tier III stream habitat survey protocol) to lateral and off-channel macrohabitats between the three rivers confluence and the mouth of the Yentna River (PRM 32.3) to address potential effects on off-channel aquatic habitats. However, AEA opposes extending remote line mapping into the Lower River because the very large size and channel complexity of the Lower River makes it impractical to map at the mesohabitat level.

AEA notes that it does not propose habitat survey efforts in main channel habitats because the predicted project-induced flow changes in the main channel habitats are well within the natural variation and thus would not be expected to affect aquatic habitats. Additionally, AEA notes that the downstream extent of the proposed off-channel survey effort would be PRM 32.3 (the lower extent of LR-4), because model predictions indicate that water surface elevation changes in off-channel lateral habitats downstream of this point would be too small (on the order of a few inches) to have any measurable effect on aquatic habitats.

In addition, AEA asserts that NMFS and FWS's request to extend the geographic scope of the videography and mapping effort down to the Cook Inlet (RM 0.0) is not feasible based on findings from AEA's test videography effort. Results from the test videography effort showed that videography flights would need to occur a height of 400 feet or lower to visually differentiate mesohabitat types of riffle, glide, pool, or run and would require three to five paths at this altitude to cover the mile-wide channel section.

[29] We note that in its request, NMFS appears to erroneously reference the three rivers confluence (PRM 102.4); however, its comment/request is specific to the lowest 30 miles of the Susitna River from the Yentna River confluence (PRM 32.3) to Cook Inlet (PRM 3.3).

Further, several parallel paths would be extremely difficult to track with GPS and would be very difficult to follow in the video. AEA estimates that it would cost $8 million to extend the remote mapping into the Lower River, as requested by NMFS and FWS. AEA argues that its proposed targeted approach to characterizing habitats with the highest potential to be affected by dam operation will meet study objective 5 at a significantly reduced cost ($300,000 to $400,000). Remote mapping of Level 3 mesohabitat types is impractical and will not improve AEA's ability to describe the loss or gain of fluvial habitat that may result from flow regulation below the proposed dam. Therefore, AEA requests that the Commission not adopt NMFS' study modification request to extend videography and mapping effort downstream to the Cook Inlet.

Discussion and Staff Recommendation

Based on current hydrologic modeling results, proposed project operations may affect lateral and off-channel habitats between the three rivers confluence (PRM 102.4) and the Yentna River confluence (PRM 32.3). Therefore, completing surveys of lateral and off-channel habitats down to PRM 29 as proposed by AEA is warranted and would inform development of any license requirements (sections 5.9(b)(4)). However, until AEA completes its required modeling verification efforts, it is premature to require AEA to conduct videography and habitat mapping effort below PRM 29.

Study 9.11 – Study of Fish Passage Feasibility at Watana Dam

Background

The purpose of the study is to develop a fish passage strategy for the proposed project. The study will evaluate various alternatives in support of three basic strategies related to fish passage: (1) proposed project without fish passage, (2) integration of upstream and downstream passage features into the current project design, and (3) the retrofit of upstream and downstream fish passage features to a project designed without passage. The study methodology includes the following tasks: (1) establish a Fish Passage TWG to provide a mechanism for consulting with stakeholders and obtaining technical input during study implementation; (2) compile salient biological, physical, and project information and develop a spreadsheet-based biological performance tool that will be used to qualitatively estimate passage success for conceptual passage alternatives; (3) conduct site reconnaissance; (4) develop and evaluate the feasibility of conceptual alternatives; and (5) finalize passage strategies.

To date, AEA has established the Fish Passage TWG and held several meetings, including two multi-day workshops and a site reconnaissance trip. AEA compiled relevant background information that will be updated as new information is developed, and the Fish Passage TWG developed a list of target species and concepts for upstream collection, upstream passage, and downstream passage. The feasibility analysis of

conceptual alternatives and development of passage strategies have yet to be completed and will occur during the next study season.

Literature Review

Requested Study Modifications

NMFS requests that AEA expand the literature review to provide more information on how well adult and juvenile salmon can navigate a large reservoir. FWS recommends that AEA also expand the literature review to provide additional information on the suitability of a large reservoir for rearing and migrating Chinook salmon and other species. NMFS states that a more thorough review of Chinook salmon passage efforts at storage dams could add clarity. Both agencies conclude that the study was not conducted as required because salient information about whether adult and juvenile fish will efficiently navigate miles of flat water without negative impacts was not included.

Comments on Requested Study Modifications

AEA argues that it has provided the requested information in appendix B of the SIR. AEA states that as required by the approved study plan, the SIR presents conceptual models for each of three representative species (Chinook salmon, Artic grayling, and burbot) and discusses how these fish are likely to respond to the future impoundment conditions based on existing information at other projects. AEA contends that the biological performance tool includes metrics that will be used to evaluate reservoir passage, including estimates of mortality and travel time. AEA also states that the physical and biological information used by the Fish Passage TWG are by design "living documents" that will be updated throughout the study as new, relevant information becomes available. Further, because the study is not yet complete, all existing and new information (some from other ongoing Susitna-Watana studies) will be used to evaluate alternatives after they are developed.

Discussion and Staff Recommendation

The approved study requires AEA to compile existing and salient background information and prepare workshop materials that include evaluation criteria and an evaluation process that would assist in the development of fish passage alternatives. That information includes biological characteristics of the river (e.g., potential target fish species and life stages, their life stage-specific periodicity and physical passage constraints, fish relative abundance and distribution upstream and downstream of the proposed dam site, locations of spawning and rearing habitats, and migratory characteristics [seasonal timing, duration] by species and life stage), physical characteristics of the river (e.g., topography, water quality and water temperature, and

hydrologic and hydraulic information); and information on project features (e.g., project conceptual drawings, operations, aerial photos, seasonal flows, and pool elevations).

AEA has provided conceptual models and metrics for the evaluation of passage alternatives based on available information and intends to further refine these tools as more information is collected from onsite studies. NMFS and FWS do not explain how the additional literature review would further inform the development of the performance tool. Instead, NMFS and FWS are essentially asking for an analysis of project effects on fish passage and behavior. While the use of existing literature to describe such effects is a well-established and accepted practice, it is typically done in the license application. While the literature review provided by AEA is not adequate by itself for our analysis of project effects on rearing and migrating juvenile and adult salmon, we expect that AEA will continue to develop that information as it prepares its license application (section 5.9(b)(4)). Therefore, we do not recommend modifying the study to require further literature review.

Migration Timing

Requested Study Modifications

NMFS requests that AEA determine the timing (now and in the future) for when juvenile salmon would need to be collected from tributary mouths, moved across the reservoir, and finally moved over the dam by evaluating current and future outmigration timing in study 9.5 and coupling that with information about earlier spring melt and warmer stream temperatures in study 7.7. NMFS states that the timing of outmigration relative to ice breakup needs to be determined because the feasible options for capturing and transporting juvenile salmon will vary with the extent of ice cover.

Comments on Requested Study Modifications

While AEA agrees that the evaluation of downstream passage alternatives is complicated by the potential for fish outmigration under ice, it contends that NMFS's proposed modification is not necessary for the following reasons: (1) relevant information on the timing of fry emergence and juvenile outmigration is available from studies 9.5 and 9.6 and will be considered in the analysis along with relevant periodicity information from the literature; and (2) the biological performance tool will allow the Fish Passage TWG to adjust migration timing to understand the implications for inter-annual variability, as well as help assess the risks associated with types of passage facilities that may not be operable when there is ice cover on the reservoir or there is risk of damage from ice accumulation (e.g., tributary collectors and other downstream passage facilities within the reservoir).

Discussion and Staff Recommendation

The information AEA compiled that pertains to the migration timing of juvenile anadromous salmonids is consistent with what was required in the approved study plan. AEA's sampling in the Upper and Middle River and tributaries in these reaches during 2013 and 2014 indicates that the outmigration of Chinook, coho, and sockeye salmon smolts occurs primarily from June through September, although data collected in 1985 indicated that the outmigration of all three species was already in progress when sampling began during May (Roth et al., 1986).

AEA's 2013–2014 Winter Fish Study documented some downstream movement of juvenile Chinook and coho salmon between the Focus Areas that were monitored in the Middle River segment, suggesting that some downstream movement likely occurs prior to ice breakup in the tributaries upstream of the proposed dam site. However, conducting additional field studies to determine the exact timing of outmigration relative to ice breakup would be difficult and costly, and because of the low abundance of juvenile Chinook salmon in the Upper River and the inherent difficulties in sampling under ice cover, the additional effort may not yield much additional useful information. Instead, AEA's proposed approach of factoring uncertainty of outmigration timing under ice into the biological performance tool is a reasonable approach for incorporating early outmigrating salmon into the downstream passage analysis. For these reasons, we anticipate that the results of study 9.11, coupled with additional juvenile salmonid migration data collected through studies 9.5 and 9.6, will be adequate for our analysis and to develop any necessary license requirements (section 5.9(b)(4)). Therefore, we do not recommend additional studies to assess the timing of juvenile outmigration under ice cover.

In addition, we do not recommend requiring AEA to modify the study plan to include the results of study 7.7 into the downstream fish passage feasibility analysis. As we noted in our discussion for study 7.7, AEA's climate change modeling results would be too uncertain to rely on for our analysis (section 5.9(b)(6)).

Field Assessment of Devils Canyon Passage Impediments

Requested Study Modifications

FWS argues that project operations would improve passage conditions through Devils Canyon. To assess how flow changes under project operation may affect passage through Devils Canyon and salmon abundance above the dam, FWS recommends that AEA conduct a thorough assessment of the Devils Canyon passage impediments, including collecting water level and velocity profiles at different flows and cross sections.

Comments on Requested Study Modifications

AEA asserts that FWS's contention that project operation would improve passage conditions at Devils Canyon is conjecture and irrelevant to study 9.11. AEA indicates that study 9.11 will be informed by available information regarding fish species biology and ecology because even if passage were improved, there is no basis for assuming which species and how many of them would expand their range upstream into or through Devils Canyon. AEA also states that adaptability of potential passage alternatives is one of the draft evaluation criteria that would address the uncertainty around future needs for passage for an unknown number of additional fish species and life stages.

Discussion and Staff Recommendation

As we said in the February 1, 2013 study plan determination, we are not aware of any way to safely collect field data or effectively model (section 5.9(b)(6)) the extremely complex hydraulic conditions that occur within the approximately 12-mile-long class VI Devils Canyon rapid. In addition, even if such an effort were feasible, we agree with AEA that there is no way to predict how much and to what extent any other salmon species may elect to migrate upstream through Devils Canyon under a modified flow regime during project operation because numerous other factors would dictate how fish respond to any changed hydraulic conditions (e.g., habitat availability at downstream sites, behavior of individual fish). Therefore, we do not recommend requiring AEA to collect water level and velocity profiles within Devils Canyon and use this information to assess how passage conditions might change under project operation.

Ice Effects on Fish Collection Facilities

Requested Study Modifications

FWS recommends that AEA research fish collection facilities and various effects on them with respect to ice conditions, including sheet ice, anchor ice, and frazil ice formation and breakup.

Comments on Requested Study Modifications

AEA states that icing effects on passage facilities were discussed during Fish Passage TWG meetings and are already being incorporated in the fish passage feasibility study (table 2 in study 9.11, ISR, part A, appendix A: Fish Passage Technical Working Group Consultation Record).

Discussion and Staff Recommendation

The consultation record indicates that project effects on the timing of ice formation on fish migration has been a frequent topic of discussion during Fish Passage TWG meetings. In addition, the SIR lists several inputs to the biological performance

tool relative to the timing of ice formation on operation periods for collection facilities and migration timing (appendix A, table 3) and the effects of ice on the operability of different upstream and downstream fish passage concepts (appendix C). Therefore, we agree with AEA that icing effects will be addressed by the methods specified in the approved study plan (section 5.9(b)(4)); therefore, we do not recommend any modifications to the study plan to address icing.

Study 9.12 – Study of Fish Passage Barriers in the Middle and Upper Susitna River and Susitna Tributaries

Background

The purpose of study 9.12 is to evaluate the potential effects of project-induced changes in flow, water surface elevations, and sediment transport on fish access to tributaries and off-channel habitats within the Upper and Middle River. The study objectives include: (1) locating and categorizing all existing fish passage barriers (e.g., falls, cascades, beaver dams, road, and railroad crossings) in selected tributaries in the Upper and Middle River for the following target species: Chinook salmon, chum salmon, coho salmon, pink salmon, sockeye salmon, arctic grayling, arctic lamprey, burbot, Dolly Varden, humpback whitefish, northern pike, and rainbow trout;[30,31] (2) locating and documenting the type (permanent, temporary, seasonal, and partial) and physical nature of any barriers within the project's zone of hydrologic influence; (3) evaluating the potential changes to the documented fish barriers; and (4) evaluating the potential creation of new fish passage barriers within existing tributary, side channel, and off-channel habitats as a result of the project.

To date, AEA has completed aerial surveys to provide the information necessary to achieve study objective 1; the remaining field work, data analyses, and modeling necessary to complete the remaining study objectives are incomplete and are ongoing. Some of the analyses and model results needed to complete this study will be provided by other studies (i.e., studies 6.5, 6.6, and 8.5).

[30] The Upper River segment extends from the proposed Watana dam site (PRM 187.1) to the upper extent of the proposed Watana Reservoir maximum pool (PRM 232.5). The Middle River segment extends from the Susitna River's confluence with the Chulitna River (PRM 103) to the Watana dam site.

[31] The list of target species was developed in consultation with the Fish and Aquatic TWG. Northern pike will be evaluated for mainstem velocity barriers.

Collection of Additional Field Data and 2-D Modeling of all Upper River Tributaries

Requested Study Modifications

NMFS and FWS state that the methods to achieve study objective 1 were not conducted according to the approved study plan because AEA only identified physical leap barriers for adult Chinook salmon. NMFS and FWS also state that the study did not identify any other types of barriers, such as depth or velocity barriers, for all target species and life stages, including adult Chinook salmon. Therefore, NMFS and FWS request that AEA collect additional field data (e.g., channel cross-sections, channel slope, water depth, and velocity), as necessary to identify all existing leap and depth barriers for all target species and life stages, and develop 2-D models to identify all velocity barriers within all Upper River tributaries from their confluence with the Susitna River upstream to the first identified passage barrier. NMFS and FWS also state that, rather than applying velocity criteria within a 2-D modeling framework, AEA could use the additional field data to identify the location of all leap and depth barriers and then develop slope-distance relationships that could be used as a surrogate to determine whether velocity barriers are present.

Comments on Requested Study Modifications

AEA agrees that water velocities likely exceed the swimming ability of fish within many tributaries but notes that inundating the lower portion of the Upper River tributaries would decrease water velocities to near zero and thus would not impede the ability of a fish to swim upstream. AEA also indicates that the agencies' proposed study methods are not practical approaches for evaluating all potential barriers over many miles of high-gradient Upper River tributaries. AEA states that a more reasonable and alternative approach to this request to evaluate all potential barriers in Upper River tributaries for all target species and life stages would be to use the fish distribution data collected as a part of study 9.5 to determine whether fish are distributed as expected based on available habitat.

Discussion and Staff Recommendation

The approved study does not require AEA to identify and categorize potential velocity or depth passage barriers within Upper River tributaries. Rather, the objective of the study is to identify physical leap barriers such as geologic features (e.g., waterfalls and cascades), beaver dams, and perched culverts. Although AEA implied that it would evaluate the presence of physical leap barriers in Upper River tributaries for all target species (not just Chinook salmon), it appears that only physical leap barriers exceeding 10 feet in vertical height, which was the jump height criterion for adult Chinook salmon, are reported. While 10-foot vertical leap barriers would undoubtedly also be barriers for other smaller target species (e.g., resident arctic grayling and Dolly Varden) with reduced leaping abilities, the study results do not account for smaller leap barriers that Chinook

salmon can pass, but other target species cannot. The study results could overestimate the amount of lotic riverine tributary habitat that is currently accessible to target species other than adult Chinook salmon from the reservoir under project operation, particularly when the reservoir is at its lowest operating level.

Nevertheless, because of the extremely remote and rugged nature of the study sites, conducting the additional field surveys recommended by NMFS and FWS to identify all leap, depth, and velocity barriers for all 41 Upper River tributaries would require a significant level of effort and be very costly (section 5.9(b)(7)). We estimate that the field survey component alone (not counting any modeling costs) would cost at least several hundred thousand dollars because all crews would need to be transported to and from study sites by helicopter, and work would progress slowly because steep channel gradients, vegetation, and LWD jams would impede access within the tributaries. While less precise, AEA's approach using the existing fish distribution data collected as a part of study 9.5, coupled with the leap barrier data collected for this study to make inferences about whether other types of passage barriers exist in the tributaries, should provide sufficient information to inform staff's analysis (section 5.9(b)(4)) at a significantly lower cost (section 5.9(b)7)). Therefore, we do not recommend requiring AEA to conduct additional field surveys to document all leap and depth barriers for all target species, and use the survey results to develop 2-D models or slope-distance relationships to identify all velocity barriers for all target species.

Collection of Field Data and 2-D Modeling of Passage Conditions within the Project's Zone of Hydrologic Influence at all Middle River Tributary Mouths

Requested Study Modifications

NMFS and FWS suggest that fish passage barriers likely exist at most Middle River tributary mouths under low, main-stem flow conditions. NMFS and FWS state that the study was not conducted according to the approved study plan because longitudinal surveys within Middle River tributaries contain too little information to determine if fish could pass successfully, and AEA has not demonstrated an approach through which fish passage criteria can be evaluated for the target species and life stages at multiple mainstem and tributary flows. Therefore, NMFS and FWS request that AEA collect additional field data, as necessary, to develop 2-D models of water velocities to evaluate fish passage at and within all tributaries downstream of, and including, Portage Creek for all target species and life stages.

Comments on Requested Study Modifications

AEA states that 2-D modeling at all 69 Middle River tributaries is not a part of the approved study plan—the approved study plan requires AEA to develop 2-D models at seven tributaries within select Focus Areas. AEA states that expanding the 2-D modeling to include all Middle River tributaries would be very costly and unnecessary because not

all Middle River tributaries met the criteria for evaluation under this study (i.e., support migratory fish and have sufficient sediment loads to develop alluvial deltas at the tributary mouths that restrict fish passage). Instead, AEA asserts that the data it is collecting during tributary thalweg surveys (i.e., water surface elevations, depths, and velocities) can be used in combination with habitat data collected within the Middle River zone of hydrologic influence, LiDAR data, and fish distribution data from study 9.6 to evaluate if current impassable depths and velocities occur within tributary mouths.

Discussion and Staff Recommendation

AEA applied its tributary selection criteria and elected to evaluate fish passage conditions at 27 of the 69 Middle River tributary mouths.[32] Of these 27, 7 will be evaluated using 2-D models within Focus Areas, and the remaining 20 will be evaluated using 1-D models or the data obtained from thalweg surveys coupled with other sources of information specified by AEA (e.g., LiDAR data).[33] Because the study is ongoing and AEA has provided only limited study results to date, it is premature to evaluate the adequacy of AEA's proposed methods for the remaining 20 tributaries; therefore, we see no reason to require 2-D modeling at these 20 tributary mouths at this time. However, based on our review of the project record, determining the specific methods, target species and life stages, and fish passage criteria that would be applied at each tributary mouth included in the evaluation is very difficult. Therefore, we recommend that AEA include in the USR a specific description of the methods (e.g., 2-D or 1-D modeling, thalweg surveys), the target species and life stages (e.g., adult chum salmon), and fish passage criteria (e.g., depth, velocity) that were applied at each tributary mouth evaluated in the study. This would be a low-cost (section 5.9(b)(7)) reporting requirement that would improve staff's understanding of what methods were applied at each study site.

With regard to the 42 other Middle River tributary mouths that apparently will not be evaluated in this study, the project record does not appear to include any specific information on how AEA applied its study site selection criteria at each of these sites and, more specifically, the reasons why these sites were excluded from the study. As noted by NMFS and FWS in their prior comments on this study, many small tributaries provide spawning, rearing, and refugia habitat for various anadromous fish species, and project-induced flow fluctuations could affect fish passage at the tributary mouths, especially in the Middle River where the magnitude of change due to project operations would be the greatest. Although we do not agree that 2-D modeling is necessary to evaluate passage conditions at all of these sites as suggested by NMFS and FWS, we do agree that more information is needed to understand why AEA excluded each of these tributary mouths

[32] See table A in attachment 6, ISR meetings, action item for study 9.12, dated March 22, 2016.

[33] See tables on pages 35 and 38 in appendix B of study 9.12, dated November 2014.

from its evaluation. Such information would be used to inform staff's analysis of the relative importance of these tributary habitats and whether license requirements to protect access to such habitats would be needed (section 5.9(b)(4)).

Therefore, we recommend that AEA include a table in the USR identifying all 42 Middle River tributaries that were not selected for evaluation in study 9.12 and provide specific explanations using AEA's study site selection criteria (e.g., no migratory fish, lack of a sufficient sediment load to develop an alluvial delta) on why it excluded each tributary mouth from the fish passage barrier analysis.

Winter Water Depth and Water Velocity within Middle River Focus Areas

Requested Study Modifications

NMFS and FWS state that ice formation during the winter can cause high water velocities that may prohibit fish passage into slough and side channel habitats during the winter. NMFS and FWS contend that AEA's ice processes study has not demonstrated that it can accurately predict water velocities and depths in these habitats under ice cover conditions. Therefore, to evaluate fish passage into these habitats under ice during the winter, NMFS and FWS recommend that AEA collect water depth and velocity measurements throughout all slough and side channel habitats in January and February in all Middle River Focus Areas. In addition, NMFS and FWS request that AEA install water level recorders and develop stage-discharge relationships at multiple locations within all Middle River Focus Area sloughs and side channels during January and February to estimate water velocities and determine whether ice conditions are creating velocity barriers.

Comments on Requested Study Modifications

AEA agrees that velocity, depth, and ice barriers to fish passage into off-channel habitats during the winter are likely and that the project has the potential to affect these conditions. However, it contends that 2-D modeling implemented as part of studies 6.6, 7.6, and 8.5 will be sufficient to predict water depths and velocities under ice in these habitats, and therefore, the additional depth and velocity measurements and water levels recorders are not necessary. AEA also indicates that the water level recorders would not provide meaningful data because they do not provide accurate readings under ice-cover conditions.

Discussion and Staff Recommendation

Collecting water depth and velocity measurements and installing stage recorders throughout all slough and side channel habitats in January and February in all ten Middle River Focus Areas could be useful for assessing existing passage conditions into these important habitats under ice-cover conditions. However, the level of effort needed to complete the requested modification would significantly increase the cost of the study

(section 5.9(b)(7)) and pose substantial safety issues because all of these sites would need to be accessed regardless of whether it is safe to do so. According to table 4.3-4 of the ISR, part A for study 9.12, 67 unique off-channel habitats exist within the Middle River Focus Areas. Collecting the requested data at these 67 sites would require AEA to access each of them a minimum of two times during the winter (i.e., once each in January and February), and repeatedly drill through the ice during each visit to collect the depth and velocity profiles and to install or remove the stage recorders. We agree with the NMFS and FWS that AEA has demonstrated its ability to successfully collect stage data under ice, and that the field measurements and stage recorders would enable AEA to collect data on passage conditions under existing conditions. However, AEA would not be able to predict changes due to project operation. Therefore, AEA's proposed modeling would still be needed to evaluate project effects.

Although AEA has yet to complete its proposed 2-D modeling of the Middle River Focus Areas under ice-cover conditions, the River2D model has the ability to predict water depths and velocities under an ice cover (Waddle, 2007), and AEA has already committed to providing model results for existing conditions and various project operating scenarios. Therefore, we anticipate that AEA's proposed modeling approach will be adequate to inform staff's analysis of passage conditions in off-channel habitats under existing conditions and proposed project operation (section 5.9(b)(4)), and we do not recommend requiring AEA to collect the additional depth and velocity data or install additional stage recorders in slough and side channel habitats within Middle River Focus Areas.

Integrate Study Results to Model Tributary Delta Formation within the Reservoir Varial Zone

Requested Study Modifications

NMFS and FWS indicate that reservoir inundation would modify riparian vegetation and sediment transport of tributaries within the reservoir varial zone. Therefore, they recommend that AEA coordinate with study 8 to evaluate post-project changes in tributary channel geometry and water velocities to evaluate fish passage criteria within the reservoir varial zone.

Comments on Requested Study Modifications

AEA states that study 8.6 does not extend into the Upper River and study 6.6 does not include modeling of Upper River tributary mouths; therefore, no results from these studies are available to incorporate. Instead, AEA indicates that it will continue to incorporate all relevant data from all studies to characterize baseline conditions and complete a comprehensive analysis of project effects on tributary habitat and passage conditions within the reservoir varial zone in the license application.

Discussion and Staff Recommendation

Because the geographic scope of studies 8.6 and 6.6 does not include the reservoir, no results from these studies are available to incorporate into the reservoir tributary passage analysis at this time. However, study objective 4 is to evaluate the potential creation of fish passage barriers within existing tributary habitats in the Upper River as a result of project operation. According to the ISR, part D (Section 8, *Steps to Complete the Study*), AEA intends to meet this study objective by evaluating the physical barrier and geomorphological field data collected at the tributary mouths through study 6.5, together with anticipated reservoir operations and associated water surface elevations. We anticipate that AEA's approach for evaluating fish passage into reservoir tributaries will be sufficient for staff's analysis (section 5.9(b)(4)).

Expand the Study to the Lower River

Requested Study Modifications

NMFS and FWS recommend that AEA extend the study downstream to include the Lower River. NMFS and FWS state that preliminary modeling results suggest there would be a 2-foot fluctuation in water surface elevations in the Lower River downstream of the Yentna River confluence, and such fluctuations could affect the ability of all target species and life stages to access Lower River tributaries.

Comments on Requested Study Modifications

AEA proposes a phased approach to determine whether to extend the study to the Lower River, and it has defined criteria in the ISR, part C, section 7.1.1 that it will use to decide whether to expand the study downstream. AEA intends to use information gathered from this study and from studies 6.6, 8.5, and 9.6 to make that determination. If the study results collectively indicate that the project would cause barrier formation and significant adverse effects on fish passage into tributaries and off-channel habitats in the Middle River, then AEA will first expand the evaluation to the upper end of the Lower River segment beginning at Trapper Creek (PRM 94.5) and Birch Creek (PRM 92.5), and then add additional sites farther downstream (e.g. Sheep Creek, Caswell Creek) as needed based on the anticipated magnitude of project effects. Therefore, AEA does not propose to expand the study downstream at this time.

Discussion and Staff Recommendation

The geographic scope of the approved study plan includes the Upper River and Middle River segments and does not extend to the Lower River. Because AEA has yet to complete its preliminary analysis of project effects on passage conditions in Middle River tributaries, it is premature to require AEA to expand the study farther downstream at this time. Therefore, we do not recommend that AEA extend study 9.12 to the Lower River.

Study 9.13 – Aquatic Resources Study within the Access Alignment, Transmission Alignment, and Construction Area

Background

The purpose of study 9.13 is to characterize baseline conditions of aquatic resources in the vicinity of the proposed project's facilities, including access roads, transmission lines, airports, and construction areas, and evaluate the potential for the project to affect these resources. Data from this study will also be used to determine the least environmentally damaging alternatives for the purposes of permitting under section 4.4(c) of the Clean Water Act and to develop any necessary protection, mitigation, and enhancement measures. The study has the following objectives: (1) characterize aquatic habitat 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 habitat and species located in the vicinity of construction areas for the dam and related hydropower facilities.

AEA has yet to complete any field data collection for this study but proposes to complete the data collection in the future and include the results in the USR.

Requested Study Modifications

Ms. Rebecca Long requests that AEA monitor water quality to assess baseline water quality conditions at stream crossings, buffer zones, and the location of proposed project facilities. Ms. Long asserts that construction-related activities and post-project traffic are expected to increase turbidity, fine sediments, heavy metals, and hydrocarbons in the alignment areas, at airports, and in the temporary and permanent areas of disturbance. Ms. Long contends that baseline water quality sampling would provide a more thorough description of existing aquatic habitat conditions, support the development of protection, mitigation, and enhancement measures, and provide data for determining the least environmentally damaging alternative.

Comments on Requested Study Modifications

AEA states that it is already collecting information on water quality (e.g., water temperature, pH, DO, specific conductivity, and turbidity), substrate composition (including percent fines), and water clarity as part of its ongoing study plan implementation. AEA states that it does not agree that data on background levels of heavy metals and hydrocarbons are necessary to evaluate project effects or to determine the least environmentally damaging alternative because project activities would not substantially affect the existing concentrations of these parameters. AEA also states that it expects water quality to be very good in project area streams because they are in undeveloped areas and all are in nearly pristine condition. Further, AEA indicates that it will also propose to develop and implement best management practices and water quality pollution control and protection plans as license requirements to minimize project

construction, operation, and maintenance effects on water quality and aquatic resources near the locations of these project facilities.

Discussion and Staff Recommendation

Although Ms. Long does not specifically recommend that AEA include heavy metals and hydrocarbons as parameters to be monitored and assessed as part of this study, we interpret her comment to include these elements because AEA already proposes to collect baseline water quality information on the other parameters she discusses (i.e., turbidity and fine sediments).

Most of the streams that will be evaluated under this study are located in remote areas and would have minimal opportunity for elevated concentrations of metals or hydrocarbons as a result of past development activities. In addition, the development of best management practices and water quality protection plans to minimize the potential for any release of heavy metals or fuel should be sufficient to protect these waters from such releases during project construction and operation. For these reasons, there is no need for additional information on heavy metals or hydrocarbons to inform our analysis and develop any license requirements (section 5.9(b)(4)). For this reason, we do not recommend requiring AEA to collect any additional water quality data beyond what it already proposes to collect.

Study 9.14 – Genetic Baseline Study of Selected Fish Species

Background

The purpose of study 9.14 is to characterize the baseline genetic structure of Pacific salmon and other selected target species in the Lower Middle, and Upper River segments of the Susitna River. The study objectives include: (1) providing genetic samples of resident fish species captured within the Susitna River drainage to the Alaska DFG Gene Conservation Laboratory for archiving, (2) contributing to the development of genetic baselines for the five species of Pacific salmon spawning in the Middle and Upper River, (3) characterizing the genetic population structure of Chinook salmon from the Susitna River and other tributaries to upper Cook Inlet, (4) examining the genetic variation among Chinook salmon populations in the Susitna River drainage for mixed stock analysis (Hallerman, 2003),[34] and (5) estimating the annual percentage of juvenile Chinook salmon in selected Lower River habitats that originate from the Middle and Upper River if sufficient genetic variation is found for mixed stock analysis. Information from this study will be used in combination with other studies to assess potential effects of the project on fishery resources.

[34] Mixed-stock analysis is a statistical estimation of the composition of an assemblage of organisms, based on genetic data, which determines what members of a particular population are represented in the assemblage.

To date, AEA has collected some genetic samples through implementation of studies 9.5, 9.6, and 9.7. Some additional genetic sample collection will continue during ongoing implementation of studies 9.5 and 9.6. Genetic sample analyses are incomplete, but AEA proposes to complete the analyses in the future and include all results in the USR.

Collect Genetic Samples from the Target Numbers of Resident Fish Species

Requested Study Modifications

NMFS and FWS state that, although genetic samples were collected and archived for 15 resident fish species, the target sample sizes for resident fish species were not met. Therefore, NMFS recommends that AEA conduct additional sampling to ensure it meets the sample size targets for all resident fish species.

Comments on Requested Study Modifications

AEA states that the objective of the approved study plan is to opportunistically collect genetic samples for resident fish sampled as part of other studies. AEA states that the approved study plan does not provide for analyzing the resident fish samples; rather, it only requires submitting the resident fish samples to the Alaska DFG Gene Conservation Laboratory for archiving. AEA also states that the number of genetic samples to be collected for resident fish species are targets and are not definitive sample size requirements because the abundance of each species is unknown. AEA indicates that it does not propose any additional dedicated sampling for resident fish species through this study, but that it will continue to opportunistically collect genetic samples for archiving during ongoing implementation of other licensing studies.

Discussion and Staff Recommendation

An objective of the study is to "[d]evelop a repository of genetic samples for fish species captured within the entire Susitna River drainage, with an emphasis on those species found within the Middle and Upper Susitna River." AEA proposed to accomplish this study objective by collecting a target of 50 representative samples for each target resident species and submitting them to the Alaska DFG Gene Conservation Laboratory. As indicated by AEA, the study objectives do not include analyzing the samples.

Our review of the study reports indicates that AEA did not meet its target for six resident species, obtained no genetic samples for six other resident species, and met its sample size targets for nine resident species.[35] The objective of the approved study plan is to opportunistically collect genetic samples for resident fish sampled as part of other studies, which AEA accomplished. The approved study plan does not require AEA to

[35] See table 4-6 of 2014 Implementation Report, dated October 2015.

collect a specific number of genetic samples for each resident species. The information that AEA collected will be sufficient to generally describe the baseline genetic structure of most resident species (section 5.9(b)(4). Therefore, we see no reason for requiring AEA to continue collecting resident fish genetic samples, although AEA could continue to do so if it wishes.

Collect Additional Genetic Samples from Sockeye Salmon

Requested Study Modifications

NMFS and FWS state that, while genetic samples were collected from the five species of Pacific salmon, the sockeye salmon samples were not from fish collected in new locations. Therefore, while they are useful to augment the existing sockeye salmon genetic baseline, NMFS request that AEA collect additional genetic samples from sockeye salmon in locations where they have not previously been collected, in order to expand the sockeye salmon genetic baseline, especially in the Middle River.

Comments on Requested Study Modifications

AEA states that the sockeye salmon genetic baseline for the Susitna River has been established since the early 1990s through samples taken from major spawning aggregates by Alaska DFG, and AEA's efforts in 2013 yielded a few more samples from 10 new locations in the Middle River. AEA asserts that these data collectively demonstrate that the current sockeye salmon genetic baseline includes most, if not all, of the vulnerable populations within the Middle River; therefore, additional sampling targeting sockeye salmon is unnecessary to meet the study objective.

Discussion and Staff Recommendation

An objective of the approved study plan is to "[c]ontribute to the development of genetic baselines for each of the five species of Pacific salmon spawning in the Susitna River drainage." AEA proposed to achieve this study objective by collecting 100 genetic tissue samples from spawning aggregates of pink, chum, sockeye, coho, and Chinook salmon in the Middle River. The approved study plan also states that the number of genetic samples associated with each collection are targets, rather than requirements, because the abundances of each species and stock is unknown.

AEA collected 376 sockeye salmon genetic samples in the Middle River, with 119 of these originating from 10 previously unrepresented spawning aggregates. Therefore, AEA's sockeye sample size exceeds the study target and contributes some additional genetic information from previously unrepresented locations. The information collected is sufficient to meet the study objectives (section 5.9(b)(1)) and inform our analysis (section 5.9(b)(4)); therefore, we do not recommend a requirement that AEA specifically dedicate additional sampling effort to collect additional sockeye genetic samples from new locations in the Middle River.

Collect and Analyze Additional Genetic Samples from Chinook Salmon Outside of the Susitna River Drainage

Requested Study Modifications

NMFS and FWS state that the Chinook salmon samples that were collected augmented the existing genetic baseline for this species, but genetic sample size targets for Chinook in other upper Cook Inlet drainages outside the Susitna River Basin were not met. NMFS therefore recommends that AEA conduct additional sampling outside the Susitna River Basin to collect the target number of Chinook genetic samples.

Comments on Requested Study Modifications

AEA states that its proposed sample sizes are targets and are not definitive requirements. AEA also states that collecting additional genetic samples from Chinook salmon from other upper Cook Inlet drainages outside the Susitna River Basin is not necessary for an assessment of project effects; rather, such samples will only provide a context of the genetic structure of Chinook salmon populations within the Susitna River Basin. AEA also states that additional Chinook samples from outside the basin are unnecessary for testing the hypotheses established by study objective 3.[36]

Discussion and Staff Recommendation

We agree with AEA that the proposed sample sizes for Chinook salmon in other upper Cook Inlet drainages outside the Susitna River Basin are targets and are not definitive requirements. The approved study plan includes targets of 100 individuals (already archived plus new samples) from each non-Susitna tributaries of Knik Arm and northwestern Cook Inlet. As noted by AEA, the purpose of these genetic samples is to augment the existing baseline for Chinook salmon outside the Susitna River Basin to provide a general understanding of the genetic composition of various Chinook salmon stocks of Cook Inlet. Our review of the study reports indicates that in 2013 and 2014, AEA contributed a total of 56 samples from Knik Arm tributaries and 47 samples from northwestern Cook Inlet tributaries to the existing Chinook salmon genetic baseline.[37] Including previous samples already archived at the Alaska DFG Gene Conservation

[36] Study objective 3 tests three hypotheses: (1) Chinook salmon above Devils Canyon represent self-sustaining populations that are genetically isolated from Chinook salmon aggregations below Devils Canyon and potentially locally adapted, (2) Chinook salmon above Devils Canyon represent successful reproduction in the upper river but also experience a high level of introgression from Chinook salmon below Devils Canyon, and (3) Chinook salmon above Devils Canyon originate from aggregates below Devils Canyon.

[37] See table 4-1 of 2014 Implementation Report, dated October 2015.

Laboratory, the total number of samples now available for analysis from various tributaries of Knik Arm and northwestern Cook Inlet are 584 and 726, respectively. Based on this information, it appears AEA has contributed some (albeit a limited quantity) additional Chinook genetic samples from non-Susitna River drainages. Because AEA's analyses of the genetic data are ongoing, it is unclear at this time if the existing archived samples coupled with the new samples collected by AEA would be sufficient to meet the study objective of providing a genetic context of upper Cook Inlet Chinook salmon. However, while this study objective would be useful for describing the existing environment for the genetic composition of Susitna River Chinook stocks within the broader context of upper Cook Inlet, we agree with AEA that the information to be obtained is not needed to inform our analysis or develop license requirements, because the project would not affect Chinook salmon occurring in those drainages (section 5.9(b)(5)). Therefore, we do not recommend requiring AEA to conduct additional directed sampling in streams outside the Susitna River Basin to achieve the sample size targets for other tributaries of Knik Arm and northwestern Cook Inlet.

Additional Summary Report for Review

Requested Study Modifications

NMFS requests an additional opportunity to comment on the results of the final analyses to be performed under study objective 3. Specifically, NMFS recommends that the Commission require AEA to prepare an additional summary report and provide it to the agencies and other stakeholders, prior to the Commission completing its study plan determination for the study.

Comments on Requested Study Modifications

AEA states that the study and analyses have not been completed and that all final analyses will be provided in the USR.

Discussion and Staff Recommendation

The pre-filing portion of the ILP provides the opportunity for study review and requests for study plan modification after an applicant files its ISR and USR (section 5.15). AEA indicates that all final analyses for this study will be provided to all licensing participants and the Commission in the USR, which is consistent with the Commission regulations. Therefore, all participants will have ample opportunity to review the results without requiring AEA to prepare a separate stand-alone report on the results of study objective 3 for stakeholder review and comment.

Collect and Analyze Additional Genetic Samples of Upper River Chinook Salmon

Requested Study Modifications

NMFS and FWS state that it is impossible to test the temporal stability of allele frequencies in Upper River Chinook collections because temporal replicates, needed to confirm the diversity and origin of the Upper River populations, were not collected. NMFS and FWS also contend that because AEA plans no further sampling, the three hypotheses under study objective 3 cannot be fully evaluated. Therefore, NMFS and FWS recommend that AEA collect and analyze additional genetic samples from Upper River spawning adult and rearing juvenile Chinook salmon.

Comments on Requested Study Modifications

AEA states that temporal replicates of Chinook salmon were collected upstream of Devils Canyon in 2012, 2013, and 2014. AEA also states that it plans to collect genetic samples from juvenile Chinook as part of ongoing fish sampling under studies 9.5 and 9.6. AEA notes that if the results of planned genetic analyses suggest that additional adult samples are necessary for clarification of the genetic populations of Chinook salmon in the Middle and Upper River, it will undertake additional direct sampling of Chinook salmon within those river reaches.

Discussion and Staff Recommendation

Hypothesis testing under study objective 3 of the approved study plan requires the collection of multiple Chinook salmon cohorts to determine whether the allele frequencies from individuals collected above Devils Canyon demonstrate high or low levels of gene flow and whether the dataset is suitable for mixed-stock analysis. Low levels of gene flow indicate allele frequencies are stable and the dataset is potentially suitable for mixed-stock analysis, whereas high levels of gene flow indicate unstable allele frequencies and the dataset is not suitable for mixed-stock analysis. Our review of the study reports indicates that AEA collected genetic samples from a total of 16 individual adult Chinook salmon over three consecutive years (2012 through 2014) and 222 individual juvenile Chinook salmon over a total of two consecutive years (2013 and 2014) of sampling in the Upper River. Based on this information, it appears as though AEA collected temporal replicates of adult and juvenile Chinook salmon from the Upper River. However, juvenile Chinook sampling as part of studies 9.5 and 9.6, as well as genetic analyses as part of this study are ongoing; therefore, it is not possible at this time to determine whether more directed Chinook salmon sampling is necessary to meet the study objectives (section 5.9(b)(1)). Therefore, it is premature to require AEA to collect additional Chinook salmon genetic samples beyond the ongoing sampling it already proposes, and we do not recommend requiring them to do so.

Additional Non-lethal Chinook Salmon Sampling Upstream of the Dam Site for Three Consecutive Years

Requested Study Modifications

NMFS states that it is necessary to increase the statistical power of the analyses involving Chinook salmon samples collected upstream of the proposed dam site to enable spatial and temporal analyses within individual streams. Therefore, NMFS requests that AEA non-lethally sample adult and juvenile Chinook salmon from upstream of the proposed dam site for an additional three consecutive years, with each year attaining a sufficient number of samples to be determined from a statistical power analysis. NMFS also requests that AEA collect age, sex, length, and habitat associations of each sample.

Comments on Requested Study Modifications

AEA states that study objective 3 was designed to investigate Chinook salmon population structure and to test hypotheses for spawning aggregates above, within, and below Devils Canyons. AEA states that the spatial extent includes the proposed dam site, but does not include the analysis of genetic population structure of spawning aggregates within individual streams upstream of the proposed dam site. AEA also comments that NMFS does not provide nor does AEA see a nexus between the tributary population structure and project effects. AEA further states that NMFS's requested modification is premature because it has not been determined whether the samples from the three years of data collection thus far are sufficient to test the hypotheses under study objective 3. AEA also states that if the planned power analyses indicate that additional samples are needed, then it will collect additional samples under studies 9.5 and 9.6.

Discussion and Staff Recommendation

An objective of the study is to "[c]haracterize the genetic population structure of Chinook salmon from upper Cook Inlet, with emphasis on spawning ground aggregates in the Middle and Upper Susitna River." Under this objective, three hypotheses are being tested to assess the genetic population structure of Chinook salmon above, within, and below Devils Canyon, which includes the proposed dam site, but not exclusively within and among each individual tributary upstream of the proposed dam site. According to the approved study plan, AEA will pool Chinook salmon genetic samples into collections following a step-wise process based on geographic proximity.[38] Under this approach, collections within the same river will be combined and then compared to adjacent collections, and if no significant differences in allele frequencies are determined between

[38] AEA defines collections that are in geographical proximity as those genetic samples that are obtained within the same river regardless of where they were collected within the river.

the two collections then those two collections will be pooled; collections will continue to be pooled until significant differences in allele frequencies are detected. Collections that exhibit significant differences in allele frequencies will be considered separate spawning populations. Subsequent genetic analyses will be based on these spawning populations.

Our review of the study reports indicates that AEA is analyzing genetic samples from a total of 16 adult and 222 juvenile Chinook collected from locations above the dam site.[39] Because the study is incomplete and additional juvenile Chinook sampling and sample analyses are ongoing, the information AEA proposes to collect as well as that already collected (section 5.9(b)(4)) may be sufficient to achieve the study objectives (section 5.9(b)(1)). Therefore, we do not recommend requiring AEA to complete three years of additional direct Chinook salmon sampling at this time.

Power Analysis to Determine Sample Size Requirements of Chinook Salmon Collections

Requested Study Modifications

NMFS states that of the number of genetic samples collected to assess genetic divergence of Chinook salmon spawning above the proposed dam site is insufficient and contends that assessing genetic divergence is very important for its fish passage decision and for developing protection, mitigation, and enhancement measures for the project. NMFS therefore requests that AEA conduct a power analysis to determine the sample size requirements needed to assess genetic divergence of Chinook salmon spawning above the proposed dam site.

Comments on Requested Study Modifications

AEA notes that NMFS's statement that the number of genetic samples is insufficient to assess genetic divergence of Chinook salmon spawning upstream of the dam site has not been confirmed because AEA is currently in the process of evaluating the genetic divergence of those collections. AEA also states that a power analysis is already incorporated into the planned analyses if genetic divergence is not detected among spawning aggregates of Chinook salmon above, within, and below Devils Canyon. AEA indicates that the planned power analysis, if conducted, will be used to determine if the statistical power is adequate to detect biologically significant differences, and if not, to determine the appropriate sample sizes required to test for differences. AEA also states that if additional samples are needed, the samples will be collected under studies 9.5 and 9.6.

[39] *See* table 4.12 of 2014 Implementation Report, dated October 2015.

Discussion and Staff Recommendation

As noted previously, Upper River juvenile Chinook sampling and genetic analyses are incomplete and are ongoing; therefore, the information AEA already proposes to collect coupled with what it has already collected (section 5.9(b)(4)) may be sufficient to achieve the study objectives (section 5.9(b)(1)). Therefore, we do not recommend requiring AEA to conduct a power analysis and develop new additional sample size requirements for Chinook salmon genetic sampling as requested by NMFS.

Study Objective 5

Requested Study Modifications

NMFS and FWS state that during the Technical Meeting of Fish Genetics on April 12, 2016,[40] AEA proposed to remove objective 5 from the study plan. NMFS and FWS state that even though sampling for juvenile Chinook salmon in the Lower River proved to be challenging and the number of samples collected to date may be insufficient for mixed stock analysis, it is important to retain this study objective because if the study results reveal self-sustaining Upper River Chinook salmon populations, it will be important to determine if and to what extent they use habitat in the Lower River. Therefore, NMFS and FWS request that AEA retain study objective 5 so that AEA can estimate the percentage of Upper River juvenile Chinook using Lower River habitats. NMFS also recommends that additional and alternative sampling efforts, such as winter sampling or environmental DNA, be used to increase the sample size for juvenile Chinook.

Comments on Requested Study Modifications

AEA states that participants of the April 12, 2016, Technical Meeting of Fish Genetics agreed to remove study objective 5. AEA states that after a substantial effort to collect juvenile Chinook salmon in the Lower River, only eight individuals were sampled, all of which were from one habitat type. AEA contends that these eight individual fish represent an inadequate sample size for analyses and expects that the assumptions of the mixed stock analysis will not be met, and the results will still not be valid even after additional sampling effort because of a very low abundance of juvenile Chinook salmon in the Lower River. AEA also states that environmental DNA sampling will only provide presence/absence data and not genotypes of individuals that will be needed for mixed stock analysis.

[40] *See* Meeting Summary and Decision Points for Technical Meeting of Fish Genetics Study 9.14, dated April 12, 2016.

Discussion and Staff Recommendation

Determining the proportion of Upper River juvenile Chinook rearing in the Lower River depends on whether Upper River populations demonstrate sufficient genetic divergence from Middle and Lower River populations to differentiate between them among a mixture of individuals. It also depends on capturing sufficient numbers of juvenile Chinook in the Lower River to draw meaningful conclusions. Based on the genetic study results available to date, it is unknown whether AEA will be able to differentiate between Chinook originating from the three different river segments. It is also unknown whether AEA will collect sufficient numbers of juvenile Chinook in the Lower River to draw any meaningful conclusions about how many Upper River Chinook rear in this river segment. However, based on the level of sampling effort implemented in the Lower River and corresponding poor results reported thus far,[41] it seems likely that a significant level of additional sampling effort will be needed to capture sufficient numbers of juvenile Chinook in the Lower River to determine the proportion of Chinook rearing in this river segment that originated from habitats upstream.

Regardless, we are unclear why this information is needed or how it will be used to inform our analysis or to develop license requirements (section 5.9(b)(4)). Chinook salmon are an extremely important resource that support a variety of subsistence, recreational, and commercial fisheries, and any juvenile Chinook salmon rearing in the Lower River will be treated with equal importance regardless of where in the basin they originated. Therefore, we recommend that AEA remove study objective 5 from the approved study plan.

We also do not recommend requiring AEA to conduct additional dedicated winter sampling for Chinook salmon or to collect environmental DNA data to support study objective 5. As noted above, the information to be obtained from these additional efforts toward achieving study objective 5 will not be used in our analysis or to develop license requirements (section 5.9(b)(4)).

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

Background

The purpose of the study is to collect baseline information on eulachon run timing, distribution, and habitat use in the Susitna River. The study objectives include: (1) determining eulachon run timing, duration, and population characteristics in the

[41] AEA reported that it sampled for juvenile Chinook in the lower river during the weeks of June 24, July 1, and July 8, 2013. This effort yielded a total collection of eight juvenile Chinook on July 8 from a single slough habitat.

Susitna River over two study seasons; and (2) identifying, mapping, and characterizing eulachon spawning habitat in the Susitna River.

AEA conducted field studies in 2013 from ice-out (May 28) to June 16. AEA determined eulachon run timing and spawning distribution using sonar, acoustic surveys, radio-telemetry, and visual observations. AEA measured habitat characteristics (substrate, water quality, depth, and velocity) at spawning sites and used dip nets to capture eulachon to gather data on population characteristics.

After review of 2013 results and discussion with NMFS, AEA determined that additional data are needed on eulachon spawning habitats. AEA proposes to expand surveys within the Lower River and collect additional data to support development of a wetted-perimeter eulachon spawning habitat model. Specifically, AEA proposes to sample known spawning sites and some non-spawning sites with gill nets and dip nets to evaluate whether the fixed sonar results in 2013 accurately represent run timing and duration because there is concern that spawning eulachon milling around the fixed sonar site in 2013 may have affected AEA's ability to determine run timing. The lower reach of the river, including intertidal areas, was not surveyed in 2013. AEA proposes to conduct additional visual and sonar surveys from PRM 6 to 11 to identify potential spawning locations. To enable it to better assess project effects on eulachon, AEA also proposes to develop a modified wetted-perimeter instream flow method and gather data along transects placed in known spawning areas at high, medium, and low flows for this purpose. These survey efforts will be conducted during the next study season after ice-out, similar to what was done in 2013.

Expand Surveys to Investigate Potential Movement of Eulachon into the River Prior to Ice Breakup

Requested Study Modifications

NMFS and FWS recommend that AEA expand eulachon surveys to investigate potential movement of eulachon into the river prior to ice breakup. NMFS and FWS suggest that eulachon have been documented moving into rivers prior to ice breakup, and the methods used by AEA are insufficient to document the early portion of the spawning run by not sampling before ice-out.

Comments on Requested Study Modifications

AEA states that it conducted some sampling with dip nets at known spawning locations in 2013 before ice breakup and concluded from these efforts that eulachon were not present at the time. AEA disagrees that an early, under-ice run of eulachon has been documented in the Susitna River. AEA asserts that the source used by NMFS and FWS to support their recommendation of sampling before ice-out (Vincent-Lang and Queral, 1984) did not sample for eulachon under the ice but employed standard gill nets, dip nets, and electrofishing and noted that "Earlier sampling both years was precluded due to river

ice conditions." AEA states that the overall run timing in 2013 was consistent with eulachon spawning study results from the 1980s, supporting its belief that the sampling was adequate to capture the beginning of the eulachon run.

Discussion and Staff Recommendation

AEA attempted to sample some sites for eulachon presence in 2013 prior to ice-out and did not detect any eulachon during this period. Although it is possible that a small portion of the eulachon run may have entered the Susitna River prior to when AEA initiated the bulk of it study efforts after ice-out, the results of AEA's 2013 eulachon sampling are consistent with the eulachon study results from the 1980s that showed that a large portion of the eulachon run entered the river following ice-out. Additionally, although NMFS and FWS indicate that AEA may have missed a portion of the run that entered the river prior to ice-out, neither NMFS nor FWS provide any specific information or proposed methods for how AEA could reasonably or safely sample the eulachon run under ice-cover conditions; why it is necessary to determine precisely when the first eulachon enter the river to evaluate project effects; or provide sufficient evidence that a significant portion of the run is entering the river prior to ice-out. We conclude that AEA's proposed methods of sampling after ice-out will be sufficient to meet the study objectives (section 5.9(b)(1)) of characterizing the run timing and spawning distribution of the eulachon run, and we do not recommend requiring AEA to expand eulachon surveys to investigate potential movement of eulachon into the river prior to ice breakup.

Conduct Two Additional Years of Sequential Data Collection throughout the Entirety of the Eulachon Spawning Runs

Requested Study Modifications

NMFS and FWS recommend that AEA collect at least two additional years of data throughout the entirety of eulachon spawning runs, including before ice breakup, to document the size and phenology of each annual run and the variability in spawning distribution.

NMFS believes that sampling in 2013 was not sufficient to qualify as the first year of study. NMFS believes that, due to lack of sampling before ice-out, any eulachon migrating earlier could have been missed. Additionally, NMFS states that another year of data collection is warranted because anomalous environmental conditions in 2013 (late ice breakup) were not representative of baseline conditions.

Comments on Requested Study Modifications

AEA states that NMFS and FWS have not demonstrated that AEA did not follow the approved study plan to achieve study objectives and that they seem to be creating a new objective without justifying why the information to be collected (i.e., run size) is important to evaluating project effects. AEA disagrees that estimates of annual run size

are necessary for the study and points out that the approved study plan does not include an objective to document eulachon run size. AEA states that the results of the 2013 study show the spawning distribution of eulachon in the non-tidally influenced portion of the mainstem Susitna River is similar to that found in the 1982 and 1983 studies.

Discussion and Staff Recommendation

Although two additional consecutive years of sampling could be useful to provide an accurate assessment of the eulachon run size, estimating the run size is not an objective of the approved study plan (section 5.9(b)(1)), nor is it needed to inform our analysis or to develop license requirements (section 5.9(b)(4)). Rather, the objective of the study is to determine eulachon run timing, duration, and population characteristics (e.g., sex and spawning condition, lengths and weights, diet analysis, and age) in the Susitna River and characterize eulachon spawning habitat. At this point, the study is incomplete and ongoing but we anticipate that AEA's proposed study methods will be adequate for this purpose.

Additionally, AEA already completed one year of sampling and proposes to complete another year of sampling during the next study season. If the 2013 ice breakup truly was anomalous as NMFS suggests, then it is likely that the next study season would occur under a more normal breakup regime. If this were the case, the results of the next study season could be compared to the 2013 study results to discern whether the 2013 study results were affected by the late breakup. For these reasons, we do not recommend requiring AEA to complete an additional two consecutive years of eulachon sampling at this time.

Extend the Water Quality, Geomorphology, and Ice Modeling Studies to the Lower River

Requested Study Modifications

NMFS and FWS recommend that AEA extend the water quality, geomorphology modeling, and ice modeling studies to include the Lower River for assessing the effects of the project on eulachon.

Comments on Requested Study Modifications

AEA states that NMFS and FWS have not established good cause nor demonstrated that the study was not implemented as provided for in the approved study plan. AEA asserts that the approved study plan will be sufficient to analyze project effects and develop license requirements.

Discussion and Staff Recommendation

Although NMFS and FWS assert that the water quality, geomorphology, and ice modeling studies need to be extended to the Lower River "to suitably assess potential

project effects on eulachon," neither agency sufficiently explains why extending the studies would be needed to meet the eulachon study objectives. At this point, AEA's water quality, geomorphology, and ice modeling studies are incomplete and ongoing, and it is unknown how much and to what extent project effects will extend downstream into eulachon spawning habitat. Nevertheless, based on the information available to date, we see no reason to expand these three studies into the Lower River for the purpose of evaluating project effects on eulachon spawning habitat. We expect that AEA's proposed methods for evaluating eulachon spawning habitat, which include developing a wetted-surface area model, will be sufficient to inform our analysis (section 5.9(b)(4)). For these reasons, we do not recommend requiring AEA to expand studies 5.6, 6.6, or 7.6 to the Lower River for the purpose of evaluating potential project effects on eulachon habitat.

Explicitly Identify How Assessment of Project Effects on Eulachon will be Completed.

Requested Study Modifications

NMFS and FWS recommend that AEA be required to explicitly explain how it will assess project effects on eulachon.

Comments on Requested Study Modifications

AEA states the requested modification is not needed because it has already defined how it will assess project effects to eulachon in the technical memorandum, entitled: *2015 Proposed Eulachon Spawning Habitat Study Modifications*.

AEA again explains that it will use the eulachon spawning habitat model to quantify and compare the availability of water depths and spawning-sized substrate under pre- and post-project conditions. In addition, it will use the wetted perimeter model to define the flow below which aquatic habitat conditions for spawning eulachon rapidly decline and will use that information to represent the minimum mainstem flow needed to protect suitable spawning habitat.

Discussion and Staff Recommendation

AEA has explained how it intends to assess project effects on eulachon spawning habitat, which is primarily through the development of a wetted-surface area model to evaluate project-induced changes in streamflows on eulachon spawning habitat. At this point, we expect that the information AEA collected in 2013 (section 5.9(b)(4)) coupled with the additional information it proposes to collect during the next study season, including its proposed wetted-surface area model, will be sufficient to inform our analysis and develop license requirements (section 5.9(b)(4)). Therefore, we do not recommend requiring AEA to modify the study to provide more information on how it will assess project effects on eulachon.

Study 9.17 – Cook Inlet Beluga Whale Study

Background

The study objectives include: (1) documenting CIBW and other marine mammals (harbor seal, harbor porpoise, and killer whale) in the Susitna River delta, focusing on CIBW distribution and upstream extent; (2) documenting CIBW group size, group composition, and behavior within the Susitna River delta; and (3) developing a model to describe the relationships between river flows, water surface elevation, and CIBW foraging habitats in the Susitna River.

AEA completed the first year of the beluga whale study in 2013. Because of difficulties using video and camera stations to collect observations of CIBW in the lower Susitna River, AEA proposes significant modifications to the study. AEA proposes to eliminate camera stations and aerial surveys and replace them with vessel-based and land-based observers to survey and document both CIBW presence and the distribution of CIBW prey species (eulachon and adult salmon) during the next study season. AEA conducted a vessel-based pilot study in June and July 2014 and developed an FDA Implementation Plan in consultation with NMFS for the next study season. In addition, AEA proposes to replace the water surface elevation model with flow-habitat modeling because the results of the flow routing model have demonstrated significant attenuation of project effects downstream of the three rivers confluence (PRM 102.4) and even more so downstream from the Yentna River confluence (PRM 32.3) to the point where potential project effects are predicted to be less than naturally occurring variation.

Conduct Additional CIBW Surveys and Use an Analytical Approach to Evaluate Effects on CIBW and their Primary Constituent Elements Following a Study Plan Developed in Coordination with NMFS

Requested Study Modifications[42]

NMFS requests that AEA conduct additional surveys to document the in-river habitats used by CIBW following a study plan developed in coordination with NMFS. NMFS also recommends that AEA use an analytical approach to evaluating project effects on CIBW and their primary constituent elements (PCEs) and the new approach be developed in coordination with NMFS and be approved by NMFS.

NMFS states that efforts have been made with varying success to meet study objectives 2 and 3, but despite those efforts, the study objectives have not been met because the study of beluga whale distribution was not comprehensive and the

[42] NMFS also recommends modifications to a number of interrelated studies (5.5, 5.6. 5.7, 6.5, 6.6, 7.6, 8.5, and 9.9) that would provide information on how the project may affect CIBWs. Those recommendations are addressed under the specific studies.

relationship between discharge and beluga foraging has not been established. NMFS argues that the study does not show if beluga whales favor particular areas or if there is a minimum depth or habitat characteristic that confines where they go; therefore, additional surveys are needed to document the habitats utilized in the river. NMFS contends that an approach to evaluating potential project effects on CIBW and their PCEs has not yet been developed.

Comments on Requested Study Modifications

AEA agrees that additional surveys to document in-river use of habitat by CIBW are warranted and that it has proposed such modifications in the June 2014 modified RSP. Further, AEA states that on August 7 and August 26, 2014, it consulted with NMFS regarding its 2014 activities and plans for the 2015 field season. NMFS representatives provided informal feedback during those discussions and that input was incorporated into the 2015 *CIBW Implementation Plan Technical Memorandum* (September 30, 2014).

AEA agrees that the relationship between discharge and CIBW foraging has not yet been described. However, AEA maintains that a proposed structured approach to addressing the PCEs is presented in the 2015 *CIBW Implementation Plan Technical Memorandum* (September 30, 2014) for which NMFS has not provided comments. AEA explains that, as described in the 2015 *CIBW Implementation Plan Technical Memorandum*, the water surface elevation model was replaced with the flow-habitat model to address eulachon spawning and to use results from interrelated studies (studies 5.6 and 6.6) to evaluate potential project effects on CIBW foraging habitat. Furthermore, AEA contends that study 9.17 will use 11 interrelated studies to evaluate potential direct and indirect effects of the project on CIBW PCEs.

AEA contends that NMFS's modification request seems to disregard and ignore AEA's proposed modification that was developed through previous consultation. AEA also points out that NMFS's request does not provide an approach, preliminary design, or any study detail that would enable the Commission to evaluate its requested modification. Lastly, AEA also notes that NMFS has not yet submitted comments on the modified RSP or the 2015 *CIBW Implementation Plan Technical Memorandum*.

Discussion and Staff Recommendation

NMFS's request lacks sufficient detail to evaluate and does not explain why AEA's modified study plan does not meet the study objectives (section 5.9(b)). Therefore, we do not recommend AEA develop a new study plan.

Study 10.5 – Moose Distribution, Abundance, Movements, Productivity, and Survival

Background

The study objectives are to: (1) document the moose population and composition in the study area; (2) assess the relative importance of the habitat in the inundation zone, proposed access/transmission corridors, and the riparian area below the project; (3) document the productivity and calf survival of moose using the study area; (4) document the level of late winter use of adults and calves in the proposed inundation area; (5) document moose browse utilization in and adjacent to the inundation zone and the riparian area below the project; (6) document the amount of potentially available habitat for improvement through crushing, prescribed burning, or other habitat enhancement; and (7) analyze and synthesize data from historical and current studies of moose as a continuation of the 2012 big-game distribution and movements study (AEA, 2012). The study area includes the proposed reservoir inundation area and downstream along the Susitna River from the dam site to its confluence with the Chulitna and Talkeetna Rivers.

In 2012 and 2013, AEA deployed 40 global positioning satellite (GPS) and 60 very high frequency (VHF)-radio collars and conducted aerial radio tracking, or telemetry, from 2012 to 2015. AEA deployed an additional 20 GPS collars in March 2015. Monitoring of all VHF telemetry and GPS collars continued through March 2016. All GPS collars collected small-scale movement throughout the year. This work included three full spring seasons (2013, 2014, and 2015) and four years of late-winter population surveys (2012, 2013, 2015, and 2016) of the proposed inundation zone. AEA considers the study complete.

Collect Additional Collared Moose Survey Data during Winter Months

Requested Study Modifications

Susitna River Coalition et al. request that AEA collect additional collared moose survey data during winter, when low-elevation moose use the inundation area. Susitna River Coalition et al. state that the approved study plan calls for deploying VHF and GPS collars on moose in the project area with monthly aerial radio-tracking surveys. However, during the 2014–2015 winter, AEA reported that "the study team ceased monthly radio-tracking flights of VHF-collared moose in the winter months of December, January, February, and April." Susitna River Coalition et al. contend that this modification biases the results against locations at a time when moose are most likely to occur in the area that would be most affected by the proposed impoundment. Susitna River Coalition et al. state that they do not believe that AEA can meet the approved study objectives without collecting year-round data on moose populations in the vicinity of the inundation zone.

Comments on Requested Study Modifications

AEA states that surveys were conducted in November 2014 and March 2015. Also, in lieu of these surveys, the monitoring period was extended another year and additional animals were GPS collared, providing more valuable data. AEA maintains that the telemetry information gathered is sufficient to fulfill the study plan objectives to assess the relative importance of the habitat in the inundation zone, proposed transportation corridors, and the riparian area below the project, and to document the level of late-winter use by adults and calves in the proposed inundation area. AEA notes that the study plan indicates that GPS collars will be removed in November of 2014 or March 2015, but AEA exceeded that requirement by deploying 20 additional GPS collars in 2015 and monitoring all active VHF and GPS collars through March 2016.

In addition, AEA states that use of the proposed reservoir inundation area by moose during late winter was documented through multiple aerial surveys. AEA notes that the study plan requires two late-winter population counts of the inundation zone, and AEA actually completed population counts of moose using the inundation area during late winter in 2012, 2013, 2015, and 2016, thereby exceeding the study plan requirements. AEA contends these data provide ample information to accomplish the objective of the approved study plan.

Lastly, AEA explains that reducing winter surveys did not bias the VHF data because AEA will be use the VHF data to create a separate kernel density analysis for each season, which will be reported in the USR. AEA also notes that GPS-collared moose provides fine-scale movement data throughout the year, including the winter months.

Discussion and Staff Recommendation

As described above, AEA collected multiple years of data in place of the suspended 2014–2015 monthly winter surveys to document winter use of moose in the inundation zone, in several cases exceeding the requirements of the approved study plan. Staff conclude that the information that would be obtained through additional surveys would not justify the estimated cost ($400,000) and effort (section 5.9(b)(7)). Furthermore, we conclude that the information is sufficient to fulfill the study plan objectives and allow staff to develop any necessary license requirements (section 5.9(b)(4)). Therefore, we do not recommend AEA conduct additional surveys for moose.

Collect Additional Moose Browse Data

Requested Study Modifications

Susitna River Coalition et al. recommend that AEA collect additional moose browse data on Cook Inlet Regional Working Group (CIRWG) lands near the dam site

and adopt plot selection and categorization methods that consider elevation and proximity of the plots to the project area and the Susitna River.

Comments on Requested Study Modifications

In 2013, CIRWG lands were unavailable for first-year browse survey sampling efforts; however, AEA states that flexibility of the implemented browse survey methods (Seaton 2002; Paragi et al., 2008; Seaton et al., 2011) allowed the study team to work around the CIRWG lands and still meet the study objectives. AEA explains that its browse survey technique is an established, peer-reviewed method to assess browse use on a large scale. The method requires over-selecting potential sampling sites to accommodate for sites that are unavailable for sampling due to lack of landing sites, lack of vegetation, or absence of browse species. In addition, AEA states that it conducted an additional browse survey in March 2016, which included CIRWG lands in the proposed reservoir inundation zone and riparian areas downstream from the proposed dam to address Susitna River Coalition's concerns.

AEA further explains that the 2013 browse survey was intended to evaluate broad-scale browse removal across the entire moose study area and not just in the project area, which is why the second, more focused browse survey in the proposed inundation zone and downstream riparian areas was conducted in 2016 (which included CIRWG lands). Therefore, AEA contends that the telemetry information gathered is sufficient to fulfill the study plan objectives and that no additional browse surveys are required. AEA states that analysis of the data set gathered under this study will be compared and integrated with historical and current study data, as appropriate, and fully described and discussed in the USR.

Discussion and Staff Recommendation

Although the first-year browse survey did not include CIRWG land survey plots, the browse utilization survey data collected in 2013 and 2016 adequately meets the study objective. Therefore, we expect that the results of the final study, which will include an analysis of the historical data, will be adequate to assess impacts and to develop any necessary license requirements (section 5.9(b)(4)). Therefore, we do not recommend requiring AEA to conduct any additional seasonal or annual surveys.

Collect Additional Survey Data due to Anomalous Weather Conditions

Requested Study Modifications

Susitna River Coalition et al. state that the moose study should be modified to require AEA to collect additional survey data to replace the information that was collected under anomalous weather conditions in 2013. Susitna River Coalition et al. assert that these abnormal conditions likely affected moose movements, calving area, and

survival of the moose in the project area; and since very few years of moose telemetry surveys were planned, it is critical that baseline data is reliable.

Comments on Requested Study Modifications

AEA asserts that 2013 did not involve anomalous environmental conditions for the purposes of 18 CFR 5.15(d)(2). AEA acknowledges that while 2013 brought unusually prolonged winter conditions and late arrival of spring conditions, those conditions were still within the range of historical observations. In contrast, AEA explains that other years of study were characterized by light snowfall and early breakup, so the study data were collected across a range of environmental conditions. AEA contends that Susitna River Coalition et al. make no showing that the meteorological conditions in 2013 impaired the value of the collected data for this study.

Discussion and Staff Recommendation

No evidence exists that weather conditions in 2013 affected data collection. The study results satisfy the study objectives (section 5.9(b)(1)) and are adequate for staff's analysis and development of any license requirements (section 5.9(b)(4)). AEA's surveys included three full spring seasons (2013, 2014, and 2015), four years of late-winter population surveys (2012, 2013, 2015, and 2016) of the proposed inundation zone, and two years of late winter surveys (2015 and 2016) downstream of the proposed dam. In addition, a second year of moose browse surveys was completed in March 2016, as described above. The surveys capture a range of environmental conditions, including years with harsh and more typical weather patterns. Staff conclude that the information that would be obtained through additional surveys would not justify the cost ($400,000) and effort (section 5.9(b)(7)). Therefore, we do not recommend that additional studies be conducted.

Design Browse Studies to Compare to Earlier Study

Requested Study Modifications

Susitna River Coalition et al. recommend that AEA design browse utilization studies so that at least some data would be directly comparable to the results reported by Becker and Steigers (1987).

Comments on Requested Study Modifications

AEA states that the browse survey techniques were followed as required by the approved study plan. AEA also states that the survey techniques are established methods to assess browse use at a large scale and have been published in peer-reviewed journals and used across the state. Furthermore, AEA notes that carrying-capacity models, such as the one developed by Becker and Steigers (1987), are not considered practical for free-

ranging moose populations and have not been validated at the population or landscape level.

Discussion and Staff Recommendation

AEA implemented the survey methods as described in the study plan. We conclude that the survey methods adhere to generally accepted scientific practice (section 5.9(b)(6)) and provide information sufficient to develop license requirements (section 5.9(b)(4)). For these reasons, we do not recommend requiring AEA to implement the requested alternative survey and comparison.

Conduct Additional Surveys to Identify Subpopulations of Moose

Requested Study Modification

Susitna River Coalition et al. assert that the study wrongly assumes all moose are part of the same subpopulation and recommend that AEA evaluate the results in terms of multiple subpopulations. Susitna River Coalition et al. also state that past studies (Ballard and Whitman, 1988) found 11 subpopulations with different movement patterns.

Comments on Requested Study Modifications

AEA states that the approved study plan does not include an objective to identify subpopulations, and Susitna River Coalition et al. fail to show good cause as to why the study plan should be modified to identify moose subpopulations. AEA argues that Ballard and Whitman (1988) recognized that "subpopulations are not discrete and many gradations exist," which calls into question the usefulness of identifying subpopulations for the purpose of project impact assessment. AEA further explains that Alaska DFG (K. Colson, Alaska DFG, unpublished data) conducted genetic analyses of blood samples collected from moose collared for this study and from surrounding Game Management Units (GMUs), but did not find any evidence that genetically distinct subpopulations inhabit the project area. Moose sampled throughout the study area and in adjacent GMUs formed one continuous metapopulation with intermediate levels of isolation by distance.

Discussion and Staff Recommendation

The approved study plan does not include an objective to examine moose at the subpopulation level. While some moose may be at least loosely associated with different subpopulations as described by Ballard and Whitman (1988), based on the information provided, staff agree that no strong evidence indicates that distinct subpopulations currently exist in the project area (section 5.9(b)(4)). Further, Susitna River Coalition et al. do not provide good cause as to how examining moose at the subpopulation level would help evaluate impacts and develop any necessary license requirements. Therefore, we do not recommend studies examining moose at the subpopulation level.

Study 10.6 – Caribou Distribution, Abundance, Movements, Productivity, and Survival

Background

Study objectives include: (1) documenting seasonal use of and movement through the project area by both females and males of the Nelchina and Delta caribou herds; (2) assessing the relative importance of the project area to both the Nelchina and Delta caribou herds; (3) documenting productivity and survival of caribou using the project area; and (4) analyzing data from historical caribou studies and synthesizing with recent data for the Nelchina and Delta caribou herds.

The study area encompasses the proposed reservoir inundation zone, access and transmission corridors, and associated project infrastructure. It also includes the majority of GMU Subunit 13E east of and including Broad Pass. The study area also includes drainages emptying into the Upper River in GMU Subunit 13B, as well as a small portion of northwestern GMU Subunit 13A from Kosina Creek east to the Oshetna River.

Both GPS and VHF radio collars were deployed for tracking purposes over a period of three and a half years. The study team deployed 79 GPS collars on bull and cow caribou and 47 VHF radio collars on bull caribou during spring and fall 2012. Additional refurbishing and re-deployments occurred in 2013, 2014, and 2015. Calving surveys were conducted during May through June in 2013 and 2014. Monitoring of all telemetry and GPS collars captured three full spring seasons and also served to supplement ongoing Alaska DFG caribou research in the study area. AEA extended the duration of the telemetry data collection for the study through October 2015 to gather more complete information.

Requested Study Modifications

Susitna River Coalition et al. recommend that AEA collect unspecified additional years of radio-collared data because they believe the data gathered in 2013 was collected under anomalous environmental conditions. Susitna River Coalition et al. also contend that additional years of radio-collar data are needed to determine adequate herd designations and appropriate levels of resolution for all caribou herds using the study area. Susitna River Coalition et al. and Rebecca Long also note that the study should be expanded to include additional caribou groups in the project area, specifically a permanent Chulitna group in the Chulitna Hills and a migratory group centered in the Cantwell area.

Comments on Requested Study Modifications

AEA contends that conditions encountered during this study were within the range of expected conditions (i.e., late-winter and spring breakup conditions in 2013 were within the range recorded in the 67 years of record, with 1964 being a little later and

colder and 1985 being slightly earlier). AEA comments that the three and a half years of movement data collected from late April 2012 through October 2015 are not considered anomalous and are sufficient to fulfill the study objectives. AEA notes that historically, winter conditions and severity vary widely from year to year in Alaska and they can be expected to continue to vary in the future. Additionally, AEA asserts that the fine-scale location data collected during this study show that the caribou using the Cantwell area and Chulitna Hills in the winter do not exhibit annual or seasonal fidelity to those areas; therefore, they were not considered to be separate subherds for analysis. AEA further notes that in addition to the three and a half years of current fine-scale data on caribou movements, Alaska DFG collected extensive data on migration patterns and range use by the Nelchina and Delta caribou herds over the last several decades. Once completed, AEA comments that the analysis of the multi-year data set gathered under this study will be compared and integrated with the extensive historical data, as appropriate, and fully described and discussed in the USR.

Discussion and Staff Recommendation

The goal of this study is to obtain sufficient population information on caribou to evaluate project-related effects on important seasonal ranges, such as calving areas, rutting areas, wintering areas, and migration/movement corridors. The methods and duration of the monitoring are consistent with what was required in the approved study plan.

The approved study plan required two years of data collection, but AEA actually collected three and a half years of fine-scale location data. While the monitoring period did include a year with unusually prolonged winter conditions and heavy snow, coupled with the late arrival of a cold spring, no evidence suggests that the meteorological conditions in 2013 impaired the value of the data collected or prevented the study from being implemented. In this case, it provided insights into caribou responses to harsh conditions. Caribou migration and calving were delayed during spring 2013 and calf mortality was high, but the spring migration routes were similar to other years.

While additional years of data would strengthen inferences across a range of weather conditions that more accurately reflect the natural range of variability, these data are not necessary because sufficient information exists to characterize caribou distribution, movements, population size, productivity, group size, and density in the project vicinity and develop any necessary license conditions (section 5.9(b)(4)). We anticipate that this will be particularly evident when AEA completes its analysis of current and historical data in the USR. Therefore, we do not recommend that AEA conduct additional years of radio-collar data.

Study 10.8 – Distribution, Abundance, and Habitat Use by Large Carnivores Study

Background

Study objectives include: (1) estimating the current populations of brown bears, black bears, and wolves in the study area using existing data from Alaska DFG; (2) evaluating bear use of salmon spawning streams in habitats downstream of the proposed dam that may be altered by the project; (3) describing the seasonal distribution and habitat use of wolves in the study area using existing data from Alaska DFG; and (4) synthesizing historical and current data on bear movements and seasonal habitat use in the study area.

To meet study objective 1, AEA used a mark-resight distance sampling (MRDS) statistical model in 2013 to analyze data from Alaska DFG flight transect surveys conducted in the spring 2000, 2001, 2002 and 2003. AEA estimated that 1,262 black bears and 841 brown bears inhabited the study area. AEA also correlated data from the flight transect surveys with environmental data to generate a density surface model (DSM) that predicts the number of bears likely to occur within each square kilometer of the study area in spring. AEA intends to use the DSM to evaluate effects of different project alternatives (i.e. alternative transmission line corridors, roads, and other project facilities) on bear habitat. To evaluate bear use of salmon spawning streams, AEA collected hair samples from snares at 12 locations in 2013. Due to land access issues in 2013, AEA collected hair samples from 19 locations in 2015. DNA analysis of the 2013 samples identified 16 black bears and 11 brown bears. Hair samples collected in 2015 are being processed for DNA and isotope analysis, and AEA will present these results in the USR.

AEA reviewed existing Alaska DFG monitoring data for wolf populations in the study area. The most recent data (2011) estimates 204 wolves in GMU 13. Annual harvest from 2008 to 2011 ranged from 81 to 159 wolves per year. Alaska DFG conducted aerial wolf surveys in GMU 13E in January 2015. Surveyors observed 6 groups (27 wolves).

Collection of Additional Hair Snag Data above Devil's Canyon

Requested Study Modifications

Susitna River Coalition et al. state that AEA collected hair snag data at less than one-third of the documented salmon spawning sites in 2013, leaving a data gap in year one of the study. Susitna River Coalition et al. note that although AEA collected additional hair snag data in 2015, no samples were collected above Devil's Canyon. As a result, a data gap still exists in the survey area, and it is unlikely that salmon use by bears living in the vicinity of the proposed Susitna dam site will be documented. Susitna River Coalition et al. state that continuing hair-snag studies is not only important to assess the use of salmon spawning areas by bears, but also to assess the relative density of bears in

the area between Devil's Canyon and the proposed dam site. They recommend that AEA perform an additional two to four years of hair-snag sampling, including sampling upstream from Devil's Canyon.

Comments on Requested Study Modifications

AEA states the hair-snag sampling was designed to obtain samples of bear hair for DNA analysis to quantify the minimum number of black and brown bears using the downstream area and for stable-isotope analysis to characterize the diets of those bears. AEA notes that although not as many locations were sampled in 2013 as planned, the downstream bear survey in 2015 obtained hair samples at 17 locations in the Middle River. AEA states that sampling is not needed upstream of Devil's Canyon because salmon returns in that area are too low, too geographically dispersed, and too variable from one year to the next to attract bears.

Discussion and Staff Recommendation

The approved study plan states that the size and design of the hair-snag sampling array was based on the expected densities of bears, logistical considerations for access to the area, comparison with similar studies in central Alaska, and in consultation with Alaska DFG biologists. In the SIR, AEA states the study team identified 37 documented salmon spawning sites (i.e., sloughs and tributaries) throughout the Middle River segment that were considered to be potentially suitable for deployment of hair-snag snares. Due to lack of access to private property or Alaska Railroad Corporation land, high human activity, lack of boat access, or lack of bear sign, the study team deployed hair-snag snares at 11 of those sites in 2013 and 16 of those sites in 2015. The approved study plan anticipated these access limits, and site selection followed the study plan. Figure 5.1-1 in the SIR shows the survey sites are well distributed throughout the survey area. The survey meets the study objective. Therefore, we do not recommend additional hair-snag sampling below Devil's Canyon.

AEA's fisheries studies indicate that Devil's Canyon is a barrier to salmon travel, although some Chinook salmon do pass through the canyon each year. Those that do pass through subsequently segregate into six different tributaries for spawning. These results indicate salmon congregations in any one tributary vary annually and are not likely to provide an attractive or abundant food source for bears upstream of the canyon. Therefore, placing hair snags in these areas to determine bear use of these streams or to evaluate the extent to which salmon contribute to their diet would add little value.

Based on the information available at this time, we anticipate that the isotope and DNA results of the hair snag samples, due to be filed with the USR, will be adequate for staff's analysis and to develop any necessary license requirements (section 5.9(b)(4)). Further, the completed study was conducted as required by the approved study plan. Therefore, we do not recommend AEA conduct hair snag sampling above Devil's Canyon.

MRDS Technique, Study Area Size, and Timing of Surveys

Requested Study Modifications

Susitna River Coalition et al. contend that the MRDS method used in the study is not consistent with generally accepted scientific practice. They state that this method is under development and has not been peer-reviewed for bear studies in Alaska. Susitna River Coalition et al. state that AEA conducted no habitat use or movement studies of either brown bear or black bear in the study area. They recommend that AEA capture bears, attach GPS collars to mark bears, and use the capture-mark-release (CMR) method to determine population estimates. The Susitna River Coalition et al. support the CMR method because it was the method used in the Su-Hydro studies, would provide more accurate information than the MRDS method, and would provide current data on habitat use and movement in the project area. Susitna River Coalition et al. recommend that AEA conduct an additional two to four years of study using CMR methods and incorporate density estimates from the hair-snag study component to accurately estimate the density of bears in the project area.

Susitna River Coalition et al. also contend that because the MRDS and DSM results were based only on spring surveys, the DSM is biased and does not accurately represent habitat use at other times of the year. For example, the DSM shows high bear densities in areas where food resources are not capable of supporting such high densities and shows low densities along salmon rivers where density is high in the fall. The Susitna River Coalition et al. recommend that AEA conduct additional density studies during the summer and fall.

Additionally, Susitna River Coalition et al. state that the approved study area greatly exceeds the area within which the proposed Susitna dam could conceivably affect bears and was configured for purposes unrelated to the Susitna dam studies. They contend that the current study does not provide abundance or density estimates for bears that are comparable to Su-Hydro studies conducted in 1980s. The Susitna River Coalition et al. recommend that AEA reanalyze the existing data to develop abundance and density estimates for the study area used for the Su-Hydro bear studies in 1987, which was 1,317 km^2 centered on the proposed Susitna-Watana dam site.

Comments on Requested Study Modifications

AEA argues that MRDS is an accepted and suitable scientific practice and, peer-reviewed scientific literature comparing the MRDS technique to other population estimation techniques indicates MRDS is a suitable approach for this analysis. AEA opposes using CMR methods recommended by Susitna River Coalition et al. because the advances in population sampling methods over the two decades following the Su-Hydro studies provide superior statistical techniques for estimating population density and abundance and CMR studies are substantially more costly. AEA estimates three years of CMR studies using GPS collars would cost $600,000 to $750,000. Further, AEA

believes that DSM models allow for estimating spatially explicit effects of development projects. AEA states the MRDS method has largely supplanted the CMR method in Alaska and notes that the CMR method offers no spatially explicit information, which is critical for determining which access corridors would have less impact on bears, whereas the DSM developed for this study offers an appropriate statistical and spatial framework for these inferences.

AEA notes that the hair snag sampling was designed to provide information on bear use of salmon streams and was not designed to obtain an estimate of overall bear density for the Middle River. AEA states that generating a DNA-based density estimate would require a much broader study area with more intensive sampling. Therefore, AEA contends it is not appropriate to combine the hair-snag data with the density estimation produced by the MRDS and DSM modeling exercises to estimate bear density.

AEA notes the study area follows the approved study plan and that the DSM allows for the estimation of black and brown bear population size on a square-kilometer basis; therefore, for any delineated impact area, a population estimate of affected bears can be calculated, including areas that include access and transmission lines.

Discussion and Staff Recommendation

The peer-reviewed literature (Laake, 1999) cited by AEA indicates that the MRDS method is an accepted practice and outperforms other methods. Walsh et al. (2014) also used the MRDS method to estimate brown bear population in the Togiak National Wildlife Refuge. The approved study plan requires AEA to use existing data to generate an estimate of bear populations in the study area. The objectives of the study plan do not include making inferences regarding carrying capacity or habitat suitability. The fact that the models show low densities along salmon streams is reasonable, given the model analyzes data collected in the spring, and is not evidence that the model is biased, as Susitna River Coalition et al. suggest. The results provide sufficient information to adequately meet the study objective of developing a population estimate for bears in the study area. Therefore, we agree that the MRDS statistical method adheres to generally accepted scientific practice (section 5.9(b)(6)) and do not recommend modifying the study to collect additional mark-recapture data with collared bears.

The collection of hair snag data was not designed to estimate bear density along salmon streams, but rather to evaluate bear use of salmon spawning areas and determine the importance of salmon in bear's diets. The MRDS and DSM models are designed to estimate population density. Accordingly, these two methods are not compatible for combined analysis and Susitna River Coalition et al. do not propose methods to integrate the two studies to provide more accurate density estimates. Moreover, Susitna River Coalition et al. do not provide good cause as to why study objective 1 cannot be met with the approved study methodology. Therefore, we do not recommend AEA integrate the hair-snag data into the density estimates.

Regarding the need for additional data collection in summer and fall, study objective 4 of the approved study plan includes the synthesis of existing data, including the results of the Su-Hydro tracking studies, to describe bear movements and seasonal habitat use in the study area. AEA provided this analysis in the technical memo filed in February 2013. Additional information will be presented with the results of study 10.19. We anticipate that the information provided in the 2013 technical memo and results of study 10.19, to be filed with the USR, will be adequate for staff's analysis and to develop any necessary license requirements (section 5.9(b)(4)). Therefore, we do not recommend AEA conduct additional summer or fall surveys for bears.

However, developing a population estimate for bears specific to areas directly affected by the proposed dam would be useful for comparing results of the current study with results from previous studies and for estimating direct effects of construction on bear populations. We recognize that the results would be specific to populations occurring in the narrowed study area during the 2000–2003 spring periods when the surveys were conducted. However, because part of the reasoning behind the MRDS technique was to provide estimates for specific locations, it is reasonable to require such an estimate for the project site, using the 1,317 km^2 study area from the Su-Hydro bear studies in 1987. In its reply comments, AEA states the size of the population potentially being affected within a different impact area can easily be calculated. Since no further data collection is required to provide this additional information, it would have minimal additional cost (section 5.9(b)(7)) and could further inform staff's analysis (section 5.9(b)(4)). Therefore, we recommend AEA include the results of this analysis in the USR

Analysis of the Power and Sensitivity of the MRDS Model

Requested Study Modifications

Susitna River Coalition et al. recommend that AEA conduct an analysis of the ability of the MRDS model to detect changes in bear populations over time (mode power) and the degree to which removal of bear observations affect the overall model (model sensitivity). They state that this analysis is needed to determine what level of change would be detectable using a subsequent application of the approach for post-project development and to evaluate the effect of not seeing bears present during the survey.

Comments on Requested Study Modifications

AEA argues that the intent of the MRDS model is to estimate population size and that the study plan does not include any objective to compare the population to future populations or analyze model power. AEA states that to provide a power analysis requires removing data from the model prior to model development and then using that data to test for model power. However, this results in a model with less accuracy because it does not evaluate all observations when generating the model. Because the goal is to

estimate current populations, AEA states efforts were focused on model accuracy. With regard to model sensitivity, AEA states that sensitivity analyses are not conducted for distance-sampling models, including MRDS models, because all of the relevant information is available from the model results and that removal of any group of bears has minimal effect on overall model output.

Discussion and Staff Recommendation

The goal of the study is to estimate current bear populations that could be affected by project construction and operation. It is premature to establish a need for future monitoring of bear responses to project construction and operation and whether such monitoring results need to be comparable to current study results. We anticipate that the information provided in the future USR will be adequate for staff's analysis and to develop any necessary license requirements (section 5.9(b)(4)). Therefore, we do not recommend AEA conduct additional analysis of the power or sensitivity of the MRDS model.

Wolf Surveys in the Vicinity of the Project

Requested Study Modifications

Susitna River Coalition et al. state that the study area for the desktop analysis for wolves is too large to evaluate potential project effects on wolves and the data is not suitable for measuring abundance, distribution, or habitat use by wolves within the proposed project area. They recommend that AEA designate an appropriately sized wolf study area in the vicinity of the project area, conduct additional aerial surveys, and propose more appropriate study methods. However, they do not provide any specifics.

Comments on Requested Study Modifications

AEA disagrees that the study area is too large to meet the study objectives. The January 2015 wolf survey covered the proposed reservoir, associated facilities, and all of the potential access and transmission corridor alternatives, thus AEA contends it was conducted at an appropriate geographical scale. AEA notes that the ISR does not address study objective 3 because that study component has not yet been undertaken. AEA states as part of that effort it will review historic and current monitoring data collected by Alaska DFG of wolves in GMU 13. The data will be included in the USR and incorporated into study 10.19.

Discussion and Staff Recommendation

AEA conducted the study as required by the approved study plan. Because wolves have large home ranges and the study area includes areas affected by the proposed project, the wolf population estimates provided by AEA meet the study objectives. It is premature to require study modifications to address the seasonal distribution and habitat

use of wolves until AEA completes its synthesis and analysis of available data in the USR. Staff conclude that Susitna River Coalition et al. do not provide good cause as to why the approved study does not meet the study objectives (section 5.9(b)(1)). Therefore, we do not recommend modifying the study as recommended by Susitna River Coalition et al.

Study 10.9 – Wolverine Distribution, Abundance, and Habitat Occupancy

Background

The goals of the study are to: (1) estimate the current population size of wolverines; (2) establish a population index for wolverines; (3) describe the distribution of wolverines in late winter; and (4) describe habitat use by wolverines in late winter. The study plan included two survey methodologies: (1) a sample-unit probability estimator (SUPE); and (2) occupancy-based modeling (OM). The SUPE method requires specific weather conditions, including fresh snow followed by several days of suitable flying conditions and adequate sunlight that allow surveyors to follow wolverine tracks sufficiently to identify complete movement paths and estimate the number of wolverines in a group. Surveys continue until all tracks within the sample plot are surveyed. Recognizing that suitable SUPE conditions may not occur every year, the study plan also includes the OM method as a backup. Using the OM method, surveyors conduct presence/absence surveys within sample plots to develop a population index during years when SUPE conditions do not occur. The study plan anticipated two years of OM sampling and one SUPE survey.

OM surveys were completed in 2013. However, AEA discontinued OM surveys in 2014 following publication of work from Ellis et al. (2013) indicating OM surveys were not likely to provide the power to detect statistical changes in population size. Suitable SUPE conditions did not develop in either 2013 or 2014, but AEA did complete a SUPE survey in 2015. AEA considers the study complete.

Requested Study Modifications

The Susitna River Coalition et al. recommend that AEA conduct additional SUPE surveys because (1) only one SUPE survey over a four-day period was conducted; (2) during the SUPE survey, weather conditions and pilot error prevented adequate sampling of the study area; and (3) poor study design introduced biases that increase variability and decrease reliability of the data. Susitna River Coalition et al. state that the biases include: (1) over-representation of habitats and elevations animals use in transit and under-representation of habitats where animals are relatively stationary; (2) inappropriate stratified sampling based on a priori assumptions about habitat quality; (3) potential for late winter avoidance of some habitat types due to snow depth and food availability; and (4) potential to miss individuals that did not move during the survey period. Susitna

River Coalition et al. request AEA collect at least two consecutive years of SUPE surveys.

Comments on Requested Study Modifications

AEA states that the approved study plan does not require completion of a SUPE survey in 2013. Rather, the study plan explicitly acknowledges that the weather conditions needed for a SUPE survey may not occur every year and thus includes the OM survey methods as a contingency plan that could be used in conjunction with a future SUPE survey. AEA explains that the study area used for the SUPE survey analysis varied from that described in the study plan because of unsuitable tracking conditions in the southwestern corner of the study area and dangerous survey conditions along the northwestern edge of the study area. An additional 12 selected sample units in the middle portions of the study area were not surveyed due to pilot error or logistical concerns and were subsequently treated as unselected, unsurveyed units in the analysis. However, the approved study plan recognizes that unpredictable factors could limit sampling in some of the plots selected for study. AEA states that despite the removal of these sample plots, the survey met the survey goals of sampling 45–50 percent of medium- and low-density sample units and 65–70 percent of high-density sample units.

With regard to biases inherent in the SUPE surveys, AEA states that data from the 2015 SUPE survey provides a high resolution snap shot of wolverine habitat use, albeit for a relatively brief period of time. The additional data gathered for the Terrestrial Furbearer Abundance and Habitat Use Study (study 10.10) provides longer-term measures of habitat use in mid- to late winter. AEA further states that the study team identified potential biases inherent in any survey technique based on snow-tracking surveys. Despite those potential limitations, however, AEA contends the results of the habitat-use portion of this study adequately documents patterns in wolverine habitat association, and the results of this study strongly agree with previous findings on wolverine habitat use, including those from the study area in the 1980s.

Discussion and Staff Recommendation

Objectives 1, 3, and 4 were completed, but results of the OM surveys are not suitable for creating a reliable population index (objective 2) due to low statistical power to detect changes. The intent of the OM surveys was to develop an index to support wolverine surveys under conditions not suitable for SUPE surveys. However, the results of the first OM survey and recently published findings in the literature (Ellis et al., 2013) make it clear that continued OM surveys have little chance of meeting this objective and will not contribute to our understanding of wolverine habitat use or the development of license conditions.

Weather-related challenges in implementing the SUPE survey were expected and anticipated. Although, weather conditions and human error resulted in some selected

survey areas being excluded from the survey, the survey meets the target goals specified in the study plan.

The study biases listed by Susitna River Coalition et al. are not the result of improper SUPE survey implementation, but rather are implicit components of the survey protocol, are unavoidable, and will be a component of any future SUPE surveys sought by Susitna River Coalition et al. Although the SUPE efforts were limited, AEA supplemented this data with additional wolverine data collected from study 10.10. Together, the SUPE and fur bearer surveys indicate wolverine are widespread in the study area and occur at relatively high population levels compared to other studies in the region. The results also show clear distinctions between habitat types and wolverine use that are consistent with generally understood wolverine biology. Therefore, the study provides the necessary information to evaluate potential effects of the project on this species and its habitat and is suitable for informing development of protection, mitigation, and enhancement measures during the licensing process (section 5.9(b)(4)). Consequently, we do not recommend further surveys for wolverine or wolverine habitat.

Study 10.14 – Eagles and Other Raptors

Background

The purpose of the study is to characterize population size, productivity, nesting phenology, and habitat use of raptor species. This information will be used to inform the prediction and quantification of impacts that may result from the proposed project, and to provide information required for a possible application(s) for federal eagle take (lethal or disturbance take) and/or eagle nest take permits. The objectives of this study are to: (1) enumerate and identify the locations and status of raptor nests and territories that could be affected by project construction and operations; (2) estimate project effects on the productivity of raptors; (3) estimate effects on nesting and foraging habitats by delineating suitable habitat features in a geospatial database[43]; (4) conduct field surveys and literature reviews to identify, map, and characterize the habitat-use patterns at fall and winter communal roost sites and foraging sites of bald and golden eagles and other raptor species, while describing seasonal habitat use and highlighting areas or conditions that may result in impacts on raptors; (5) assess the extent to which planned overhead transmission lines may pose a collision risk to migrating or nesting raptors and identify migratory corridors (including altitudes of raptor movements) in the project transmission line corridors; and (6) provide information on the distribution, abundance, food habits, and diet of piscivorous (fish-eating) raptors; feather samples for characterization of

[43] This work will be conducted as part of study 10.19.

mercury levels; and information on the effects of methylmercury on piscivorous raptors, for use in study 5.7.[44]

Refine Golden Eagle Occupancy Survey Methodology

Requested Study Modifications

FWS requests that the golden eagle occupancy survey methodology be refined to reduce the number of golden eagle nests classified as "possibly occupied." The methodology to assess golden eagle nests in 2013 consisted of aerial surveys of trees and cliffs; multiple passes or hovering flights were implemented when incubating adults or young were not observed. FWS recommends that AEA implement a modified methodology whereby the helicopter returns and lands near "possibly occupied nests" and the study team observes the nest for an hour or two. FWS does not identify if the data collected in 2013 need to be resurveyed using the revised methodology, or if the revised methodology will be incorporated into the second survey year.

Comments on Requested Study Modifications

AEA states that the study methods, which were developed in consultation with FWS staff, were followed as provided in the approved study plan. AEA notes that the approved study methods are consistent with FWS guidance (Pagel et al. 2010), which states that accompanying ground observations are not standard practice for helicopter surveys; rather, they are possible augmentation if deemed more convenient, more efficient, or in areas with other sensitive wildlife species.

Discussion and Staff Recommendation

AEA followed the methods described in Pagel et al. (2010) as required by the approved study plan, and we agree that the methodology is appropriate to meet the goals and objectives of the approved study. Although Pagel et al. (2010) states that follow-up ground monitoring can be combined with helicopter surveys, the protocol clearly states that ground surveys are not required. Nothing in the record indicates that the additional effort will be more convenient or efficient or needed to address other sensitive wildlife species. Rather, the remoteness of the project area, the size of the study area, and cost, make such efforts less convenient and efficient. We conclude that the methodology is consistent with generally accepted practice (section 5.9(b)(6)) and is sufficient to develop license requirements (section 5.9(b)(4)). For these reasons, we do not recommend requiring AEA to implement the requested alternative survey methodology.

[44] The mercury analysis of piscivorous waterbirds previously included in this study was moved to study 5.7.

Extend the Study Area

Requested Study Modifications

FWS requests that AEA address raptor populations downstream of the proposed dam by conducting pre-construction baseline surveys of raptor use but did not provide a downstream survey extent. FWS asserts that this information is necessary to fully understand the effects of the project on raptors because the initial results from the open water flow routing model show the post-project flow hydrograph for the Middle and Lower River would change substantially and creation and operation of the proposed dam would alter river flow and hydrology for many miles downstream.

Comments on Requested Study Modifications

AEA opposes extending the surveys of eagle and raptor use below the existing study area during the second year of required surveys. AEA states that the 2013 surveys followed the approved study plan, which was developed in consultation with FWS staff. AEA notes that the study survey area includes 3 miles around proposed facilities, access roads, and transmission corridors and 10 miles around the reservoir inundation zone. AEA also notes that all raptor nesting surveys extended across a 6-mile-wide area along the Gold Creek alignment and extended about 50 miles downstream of the dam to Gold Creek (about PRM 140).

AEA argues that the needs of raptors could be adequately addressed through study 10.19, which examines the riparian zone downstream of the dam as far as PRM 30.6. AEA notes that the riparian instream flow model will predict post-construction habitat changes and enable an analysis of potential effects on raptor habitats downstream of the proposed dam, including potential changes in nesting habitat (e.g., stands of large spruce and cottonwood) and foraging habitat (e.g., fish habitat) for bald eagles and other species of large tree-nesting raptors. AEA notes that golden eagle nesting and foraging habitats are mostly distinct from the riverine habitats that may be affected by flow alterations. AEA states that current data indicate flow alterations would significantly attenuate farther downstream from the dam site, especially below the three rivers confluence (i.e. the confluence of the Susitna, Chulitna, and Talkeetna Rivers) and changes to flows, river stage, and sediment would be minimal below the Yentna River confluence.

Discussion and Staff Recommendation

AEA conducted surveys as provided for in the approved study plan, which examined raptors on the Susitna River downstream of the dam to the confluence of Gold Creek. Data from this study, together with habitat data that will be incorporated into study 10.19, are adequate to quantitatively analyze changes in nesting habitat and foraging habitat for bald eagles and other species of large tree-nesting raptors. As such, the data meet the objectives for this study element and will enable an assessment of post-construction habitat changes and potential impacts downstream of the dam and

development of measures to minimize impacts (section 5.9(b)(4)). Consequently, we do not recommend that the study be modified to extend the survey area downstream of Gold Creek during the second year of required surveys.

Migration Survey Timing

Requested Study Modifications

FWS asserts that a potentially significant number of some birds, particularly golden eagles, were likely missed during the first study year in 2013. FWS recommends that the raptor migration surveys should begin earlier and extend later in the season.

Comments on Requested Study Modifications

AEA states that the 2013 migration counts, which were conducted between April 12–May 11 and September 16–October 15, were consistent with the study plan, which specified that the raptor migration surveys would be conducted in April–May and September–October. AEA notes that it attempted to optimize the timing windows within these months to cover the anticipated peak migration/movement periods within the constraints of safety, logistics, and budget. AEA considered beginning the spring survey in mid-March to record the earliest-migrating raptors (golden eagles), but the effort was postponed due to safety concerns of deploying observers in cold, windy, winter conditions in higher-elevation portions of the study area.

AEA acknowledges that some early- (primarily golden eagles) and late-migrating raptors might have been missed during the surveys. However, AEA notes that the study objective was to sample at suitable observation points along the transmission corridor alternatives to provide data to use in assessing the potential for collision risk to raptors (especially focused on bald and golden eagles), rather than cover the entire duration of migration and enumerate all raptors passing through the study area. AEA asserts that the data collected during the migration observations in spring and fall 2013 provide adequate samples to address the objective. AEA also asserts that although some early-migrating adult golden eagles may have been missed by not beginning the raptor migration surveys before April 12, the protracted winter season and late arrival of spring conditions in 2013 make it unlikely that a "potentially significant number" of other early-migrating raptors was missed.

Discussion and Staff Recommendation

AEA conducted the 2013 effort within the timeframe identified in the study plan (April–May and September–October). The information on peak raptor migration, along with an analysis of flight altitude and flight directions of birds present in the area, provide us with sufficient information to assess the extent to which planned overhead transmission lines may pose a collision risk to migrating or nesting raptors, identify migratory corridors, and recommend project modifications to reduce effects or other

environmental requirements (section 5.9(b)(4)). Therefore, we do not recommend any changes to the study.

Develop Survey Protocol for Small Woodland Raptors

Requested Study Modifications

FWS notes that nest surveys have successfully documented cliff nesting raptors, bald eagles, and golden eagles but were not successful in documenting woodland raptor species, including owls and smaller raptors. FWS recommends developing survey protocols to identify woodland raptors but did not provide any specific methodology.

Comments on Requested Study Modifications

AEA states that species of large woodland raptors (red-tailed hawk, great horned owl, great gray owl) were addressed by aerial surveys that included transect surveys in the proposed inundation area, all bald and golden eagle habitat within the survey area boundary, and historical (1980s) bald and golden eagle nest locations. AEA notes that the transect surveys for large woodland raptors were conducted in the reservoir inundation zone and dam/camp facilities area in 2013, and although some nests of large tree-nesting raptors were found, the survey method was modified to increase survey intensity and probability of detecting large tree-nesting woodland raptors (e.g., bald eagle) nests. AEA notes that surveyors flew thousands of miles for hundreds of hours over the variety of raptor habitats in the study area; therefore, large woodland raptor nests would have been detected if they were present.

AEA also notes that species of small woodland raptors (boreal owl, northern hawk owl, sharp-shinned hawk, merlin, American kestrel) were addressed by a combination of surveys for landbirds and shorebirds (study 10.16 and study 10.19). AEA states that targeted surveys were not conducted for species of small tree-nesting owls (boreal owl) due to safety and logistical concerns (i.e., the surveys would need to be done at night in late winter), while small diurnal raptors (northern hawk owl, small hawks, falcons) would likely be detected during the landbird and shorebird surveys. AEA notes that extensive aerial surveys of raptors in 2012–2014 and point counts and ground-based transects for landbirds and shorebirds in 2013–2014 detected low numbers of these species, indicating that they are uncommon or rare in the study area. AEA states that these species are assumed to be present and will be addressed in study 10.19 by quantifying the spatial distribution and extent of habitats likely to be used by these species, and notes that the same approach is being used for ground-nesting species of raptors (northern harrier, short-eared owl). AEA notes that surveyors collected data at hundreds of locations throughout the variety of habitats used by small woodland raptors and asserts that, with the exception of boreal owl, these species would have been detected if they were present.

Discussion and Staff Recommendation

We find that AEA conducted surveys as provided for in the approved study plan. The low numbers of documented woodland raptors may be a result of low abundance, and surveying for some woodland raptors at night in late-winter may result in safety and logistical concerns. FWS has not provided details or proposed sampling methods on how to collect additional data as required by section 5.9(b)(6). We find that the various field studies provide adequate data on woodland raptors to understand project impacts and need for environmental measures (section 5.9(b)(4)). As a result, we do not recommend requiring AEA to modify the survey protocols for woodland raptors during the additional year of field work.

Additional Years of Eagle Surveys, Including during Years of High Prey Availability

Requested Study Modifications

FWS recommends that at least one additional year of surveys, and possibly more, will be needed to properly characterize occupancy, productivity, and migration rates of eagles. FWS states that in the case of golden eagles, surveys in years of high prey availability will be necessary because both surveys were completed in years of low prey productivity. FWS states that the surveys conducted to date may not adequately document inter-annual variability in golden eagle populations and indicates that results of the 2013 surveys may be biased due to spring and summer weather conditions that FWS asserts were anomalous and likely affected eagle migration timing and routes.

Comments on Requested Study Modifications

AEA asserts that although weather conditions in 2013 were unusual, they were not "anomalous environmental conditions" for purposes of section 5.15(d)(2). AEA notes that the Commission has acknowledged the importance of gathering data over a range of conditions to assess project effects and states that FWS does not adequately demonstrate that the meteorological conditions in 2013 impaired the value of the data collected for this study. AEA asserts that it is premature for FWS to seek additional surveys before the surveys are completed. AEA states that a final year of nesting surveys and another year of spring and fall migration surveys are planned for this study, and three years of nesting surveys have been conducted to date (2012–2014), exceeding the two years required in the approved study plan. AEA notes that the approximate population cycle of snowshoe hare, which is presumably the primary prey for eagles, is 8–10 years and conducting surveys in years of high prey availability could require a study of this duration. In light of this information, AEA asserts that it is seldom practicable to conduct nesting surveys over an entire decade, particularly in view of the tightly prescribed ILP schedule.

Discussion and Staff Recommendation

Under the approved study plan, an additional year of field work is required to complete this study. Although it would be ideal for this additional year of data collection to coincide with a period of high prey availability to characterize inter-annual variability in eagle populations, it is not reasonable to require that additional (yet undefined number of surveys) be conducted until such conditions are met because it is not possible to ensure timing of a survey to coincide with high prey availability.

Study 10.15 – Waterbird Migration, Breeding, and Habitat Use

Background

The purpose of the study is to collect baseline data on migrating and breeding waterbirds in the project area to assess the potential impacts of the project and to inform the development of appropriate protection, mitigation, and enhancement measures. The study plan objectives are to: (1) document the occurrence, distribution, abundance, habitat use, and seasonal timing of waterbirds migrating through the project area in spring and fall; and (2) document the occurrence, distribution, abundance, productivity, and habitat use of waterbirds breeding in the project area.[45] The information gained from this study will be used to evaluate waterbird habitat loss and alteration and to estimate the number of migrating and breeding waterbirds that the project may affect. The study methods include (1) aerial surveys, (2) ground-based radar and audio-visual surveys, (3) breeding population surveys, (4) harlequin duck surveys, and (5) brood surveys.

Anomalous 2013 Weather Conditions and Second Year of Ground-based Migration Surveys

Requested Study Modifications

FWS asserts that the 2013 spring/summer weather conditions likely affected waterbird migration timing and perhaps routes, and those conditions should be considered anomalous environmental conditions pursuant to section 15.5(d)(2). FWS also states that no ground-based migration surveys were done in 2014. We interpret this statement as a request for a second year of ground-based radar and audio-visual surveys. If a second year of radar data is not collected, FWS recommends further technical discussions regarding the quality and objectives of the migration data.[46]

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[45] A third objective to characterize food habits and diets of piscivorous waterbirds for mercury analysis was previously included in this study but was later moved to be included in study 5.7.

[46] FWS's recommendation for further technical discussions regarding the ground-based radar and audio-visual surveys was made in its comments for the study 10.16.

Comments on Requested Study Modifications

AEA asserts that although 2013 had a prolonged winter and delayed spring ice breakup, it did not constitute "anomalous environmental conditions" per section 5.15 (d)(2).

Concerning the one year of ground-based migration surveys, AEA states that it made the decision to discontinue the ground-based surveys in 2014 because evidence suggested that the study area was not a major migration corridor. Even with the colder environmental conditions, AEA suggests that migrants are unlikely to change their flight pathways in spring 2013 when similar winter-like conditions occurred state-wide.

AEA also states that collecting species-specific migration data in a radar and audio-visual migration study is only possible when simultaneous visual observations or auditory identifications of calling migrant birds can be linked to the radar targets identified on-screen. AEA asserts that it is not clear that additional radar and audio-visual surveys will yield any more specific information on the individual species that migrate past the proposed dam site area beyond what was collected during the 2013 surveys. AEA estimated it would cost $700,000 to conduct another year of ground-based audio-visual and radar surveys of migrating birds at the proposed dam site.

Discussion and Staff Recommendation

The ground-based radar and audio-visual surveys were incorporated into the approved study plan to provide data for a collision-risk assessment of the project and recorded the volume and flight direction/altitude of all bird species passing over a site just northwest of the proposed dam. Unlike the waterbird aerial migration surveys that were conducted over two years, the ground-based migration surveys were only proposed for the 2013 spring and fall, with the decision to conduct a second year of sampling dependent on the 2013 results (i.e., whether or not the study area was deemed a major migratory corridor). In general, the numbers of waterfowl and cranes were lower during the 2013 migration periods than recorded in studies conducted at sites elsewhere in south-central Alaska, suggesting that the Susitna River Basin may not be a major migration pathway for waterbirds.

The 2013 spring migration surveys were conducted under an extended winter snow season, cold temperatures, and a late spring ice breakup condition. As indicated by the waterbird aerial migration survey results, the 2013 weather conditions likely produced a delay in migration and a shift in habitat use; specifically, waterbirds predominately occupied open riverine habitat (as opposed to ice-covered waterbodies) until late May compared to the spring 2014 results. Whether birds also shifted their overall migratory

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However, because ground-based radar surveys were conducted under study 10.15, the issue of further technical discussions is addressed in this study.

pathway is not known because the migration studies were not designed to answer this question. However, the data from aerial and ground-based surveys provide an indication of local area use during migration. The 2013 spring and fall waterbird aerial survey data (e.g., bird densities, number of species) were comparable to those from surveys in 2014 and in the 1980s, suggesting that waterbird numbers for 2013 were not significantly different from other years, and the relatively low numbers in both aerial and ground surveys support the conclusion that the Susitna River Basin is not a major migratory pathway. Whether or not the 2013 ground survey data accurately represent bird numbers for other taxa is unclear because no prior data are available for other taxa in the project area.

The weather conditions did not affect data collection, and the study results satisfy the study objectives (section 5.9(b)(1)) and are adequate for our analysis and development of any license requirements (section 5.9(b)(4)). We consider the 2013 data valid for characterizing the volume and flight patterns of bird populations migrating through the Susitna River Basin and see no strong justification for the expenditure of additional money and effort for another year of data collection (section 5.9(b)(7)). Therefore, we do not recommend that an additional year of ground-based radar and audio-visual migration surveys be conducted.

Extend the Study Area

Requested Study Modifications

FWS recommends broadening the scope of the study farther below the proposed dam because initial results of the open-water flow routing model show that the post-project flow hydrograph for the Middle and Lower River would change substantially. FWS asserts that as the hydrology of the river system changes, the use of the system by waterbirds would also change, and a pre-construction baseline of waterbird use below the proposed dam is necessary to fully understand the effects of the project on waterbirds.

Comments on Requested Study Modifications

AEA states that it conducted waterbird surveys as specified in the study plan, including aerial surveys that examined the Susitna River downstream to Gold Creek (about PRM 140; the proposed dam site is located at PRM 187.1). Nonetheless, AEA states that the results of the study 8.6 model will be used to predict post-construction waterbird habitat changes that might affect waterbirds occupying riparian areas farther downstream. AEA also states that waterbirds will be incorporated into study 10.19, which will include the riparian zone extending downstream as far as PRM 30.

Discussion and Staff Recommendation

We do not recommend extending the waterbird study area. As discussed above in the response to a similar modification request to study 10.14, we conclude that the 2013–2014 aerial survey data from this study, together with habitat and modeling data from studies 8.6 and 10.19, will be adequate for our analysis and development of license requirements (section 5.9(b)(4)).

Study 10.16 – Landbird and Shorebird Migration, Breeding and Habitat Use

Background

The purpose of the study is to collect baseline data on the occurrence and habitat use of breeding landbirds and shorebirds in the project area. The four study objectives are: (1) collect data on the distribution and abundance of landbirds and shorebirds during the summer breeding season; (2) identify habitat associations for landbirds and shorebirds; (3) evaluate changes in distribution, abundance, and habitat use of landbirds and shorebirds through comparison with historical (1980s) data; and (4) characterize the timing, volume, direction, and altitude of landbirds and shorebirds migrating through the dam and camp facilities area.

Study methods include ground-based point count surveys for breeding birds, boat- and ground-based surveys for colonially nesting swallows, and ground-based monitoring of migration using a combination of daytime visual observations and nocturnal radar sampling.

Second Year of Colonially Nesting Swallow Surveys

Requested Study Modifications

FWS requests that AEA conduct a second year of surveys of colonially nesting swallows to improve the abundance estimates reported in the ISR because swallow abundance may fluctuate substantially between years due to variability in reproductive success and survivorship. FWS asserts that additional surveys would result in a better understanding of swallow nesting activity, habitat use, and colony location changes throughout the study area. FWS also notes that 2013 results, in combination with another study year, may provide sufficient data to meet the study objectives.

Comments on Requested Study Modifications

AEA disagrees that a second year of colonially nesting swallow surveys is needed to meet study objectives. AEA maintains that its study efforts adequately documented distribution and abundance of colonially nesting swallows during the 2013 summer breeding season and identified their habitat associations. AEA states that survey coverage and efficiency in 2013 were substantially greater than required by the approved

study plan because the 2013 helicopter surveys were much more efficient than the planned boat- and ground-based surveys. As a result, the study area for the swallow surveys was expanded to include a 2-mile buffer surrounding the proposed reservoir and dam and infrastructure area, allowing the field team to survey all potential swallow nesting habitat in areas that could be directly or indirectly affected by the project. AEA maintains that the data collected in 2013 will provide at least a minimum estimate of the number of colonially nesting swallows that the project could affect. AEA plans to compare current data with the historical data reported in Kessel et al. 1982 in the USR.

AEA notes that the FWS has not provided any specific information to indicate how the data collected in 2013 are insufficient to meet the study objectives; rather, the FWS request is focused simply on obtaining additional information on annual variability in swallow abundance and more information on nesting activity, habitat use, and potential colony location changes in the study area.

Discussion and Staff Recommendation

While AEA's data collection efforts were more efficient and covered a greater area than required by the approved study plan, the approved study plan requires two years of surveys, because AEA acknowledges in the ISR, site fidelity of bank swallows to colony location is ephemeral from year to year (Freer, 1979; Hjertaas, 1984; Jones, 1987; Garrison, 1999). Its observations of inactive colonies during surveys in 2013 support this finding. AEA's own conclusions in the report appear to contradict its reply comments in that the study findings note that the majority of colonies were located in heavily eroded slopes and that "such unstable habitats suggests that substantial annual turnover in colony habitation may occur" and "conclude a second year of colonially nesting swallow surveys is still warranted given the likelihood that the observed locations of colonies may be different in subsequent breeding seasons." Avian surveys in the early 1980s (Kessel et al.,1982) did not include surveys of colonially nesting swallows, so a direct comparison of the two studies is not possible. Furthermore, bank swallows are a species in steep decline (Rosenberg et al., 2016) and listed as a species of "Greatest Conservation Need" by the 2015 Alaska Wildlife Action Plan (Alaska DFG, 2015). Therefore, because colony locations are likely to change in subsequent years and the Kessel et al. (1982) study reported limited information on swallow colonies to understand how these sites might compare to historical habitat use, we recommend AEA conduct a second year of colony surveys using the improved helicopter method and observing accessible colonies from the ground (section 5.15(d)(1)). The effort would provide important information on the distribution of swallow colonies, colony movements between years, and their tenacity to identified colony sites that may be impacted by the project. We find that information on the distribution and habitat use of swallows is worth the estimated cost of $70,000.

Request for Additional Year(s) of Point Count and Riverine/Lacustrine Sampling

Requested Study Modifications

FWS recommends AEA conduct an unspecified number of additional year(s) of point count and riverine/lacustrine sampling because AEA's efforts were insufficient to achieve targeted precision of population size estimates (e.g., a coefficient of variation [CV] ≤ 0.15), did not adequately sample habitats occurring throughout the study area, and did not meet minimum sample sizes (75–100) needed to estimate detection functions. FWS additionally asserts that birds arrived late in 2013 and 2014, and that an additional year of sampling was planned for in 2015 to include 27 percent of the study area.

Comments on Requested Study Modifications

AEA states that the two years of data collected for this study, which includes field surveys in all portions of the study area, were collected as required by the approved study plan and are more than adequate to meet the objectives. AEA asserts that it exceeded the 800 point counts required by the approved study by conducting over 2,500 point counts, and that the approved study plan did not specify a target level of precision for population size estimates. AEA asserts that data collected on 24 common species are sufficient to calculate densities, and that density estimates by habitat for those species with sufficient numbers of observations will be presented in the USR.

AEA asserts that although migration of birds in south-central Alaska was delayed in 2013 because of late snowfall, there is no indication that the migration was late in 2014. AEA adjusted the start date and spatial pattern of its surveys in 2013 and 2014 to focus surveys in snow-free areas and maximize the likelihood that breeding birds would be present at all plots surveyed, and completed the surveys as provided for in the approved study plan. AEA asserts that FWS misinterpreted the statement in the ISR that suggests 27 percent of the study area would be surveyed in 2015. AEA clarified that the 27 percent figure encompasses the areas that were not surveyed in 2013 and that the second year of survey was conducted in 2014, not 2015.

AEA states that while additional data would increase the number of detections for the common species, it would not reduce the variability in density estimates for all species, including the 50 uncommon species. AEA additionally asserts that achieving a target level of precision in population size estimates for all species recorded in the study area is not feasible within a reasonable time frame. Based on the existing data, AEA estimates that one additional year of sampling would likely produce data sufficient to meet the required minimum of 75 detections (to estimate detection functions) for only five of the uncommon species, and that many more years of sampling would be required to obtain at least 75 detections of the other uncommon species. AEA asserts that even with additional data collection, it will not be possible to derive accurate density estimates for uncommon bird species, many of which are of the greatest conservation concern. AEA states that the quantitative habitat loss and alteration data collected for other studies

are likely to be more important than the density estimates for assessing impacts and developing protection, mitigation, and enhancement measures for landbirds and shorebirds.

Discussion and Staff Recommendation

During the two years of sampling, AEA conducted over 2,500 point counts, which far exceeds the goal of at least 800 point counts per year required by the study plan and includes data from all portions of the study area over various habitat types. It would require far greater effort and time to collect enough data to calculate detection functions for many of the species or to meet the target level of precision for the population estimates recommended by FWS. This level of precision is not needed for our environmental analysis. We conclude the data collected by AEA in 2013 and 2014 are adequate (in combination with data from other studies) to identify important breeding habitats for all landbird and shorebird species that would be lost or altered due to project development, and these data should be adequate to develop license requirements (section 5.9(b)(4)). As a result, we do not recommend AEA conduct an additional year(s) of surveys.

Extend the Study Area

Requested Study Modifications

FWS recommends broadening the scope of the study to include areas below the project, but does not provide a downstream survey extent. FWS asserts that because initial results from the open water flow routing model show the post-project flow hydrograph for the Middle and Lower River would change substantially, the project has the potential to not just affect landbirds and shorebirds within the project footprint, but to affect them for many miles downstream.

Comments on Requested Study Modifications

AEA states that surveyed areas were consistent with those identified in the approved study plan. AEA explains that expected changes in habitats supporting breeding landbirds and shorebirds in downstream areas will be analyzed quantitatively in the license application using the habitat association information gathered from this study and other interrelated studies (studies 11.5 and 11.6). AEA further argues that collecting sufficient data for FWS's broadened recommended study area to achieve the precise detection limits and population estimates sought by the FWS is impractical for the same reasons noted above. AEA states that the quantitative habitat loss and alteration data collected for other studies are likely to be more important than the population estimates for assessing impacts and developing protection, mitigation, and enhancement measures.

Discussion and Staff Recommendation

We do not recommend extending the landbird and shorebird study area. As discussed above in the response to a similar modification request to study 10.14, we conclude that the point-count surveys from this study, together with habitat and modeling data from studies 8.6 and 10.19, would be adequate for our analysis and development of license requirements (section 5.9(b)(4)).

Study 12.5 – Recreation Resources and Study 12.7 – Recreation River Flow and Access

Background

Objectives of the Recreation Resources Study (study 12.5) include: (1) documenting recreation resources in the project area; (2) identifying current and future recreational use based on mail and intercept surveys, interviews, available plans, and other data; (3) evaluating potential effects of project construction and operation on recreation; and (4) developing a Recreation Management Plan for the project.

The Recreation River Flow and Access Study (study 12.7) incorporates data from study 12.5 to provide, in part, a recreation flow analysis on three mainstem reaches of the Susitna River that assesses the relationship between river flows (baseline and post-development), ice conditions, river recreation, and river travel. Objectives include: (1) documenting recreational use, experience, and river travel along each reach via surveys, interviews, field observation, and focus group discussions; (2) describing potential project effects of altered river flows on boating and other recreational use; (3) determining river ice preferences for winter recreation and river travel; and (4) describing new boating or other flow-dependent recreational opportunities may be created by the project.

The study area for both studies includes the Susitna River from the Denali Highway Bridge to the Parks Highway Bridge near Sunshine. Both study plans include provisions to extend the study area below the Parks Highway Bridge if initial results of river flow, geomorphology, and ice studies indicate that effects on recreation resources or river access are likely.

Requested Study Modifications

The Willow Area Community Organization, The Nature Conservancy, Talkeetna Community Council, NPS, and others request that the lower Susitna River, from Willow Creek (RM 50) to Susitna Station (RM 29.9) be added to the study areas for both studies, as provided in the study plans. The concerns expressed generally apply to both studies.

These stakeholders maintain that flow-related recreation and river travel along the lower Susitna River are integral to the community of Willow and nearby communities and that river use in this area is substantial and likely exceeds that which occurs in the

upstream reach between Willow and the Parks Highway Bridge. The stakeholders note that the lower Susitna River serves as a "highway" to access many trails, lodges, and private cabins west of the river. In winter, stable ice on the river is critical to area residents and recreationists, including participants in the annual Iditarod Sled Dog Race, which in some years begins in Willow.

They do not believe that the ISR contains sufficient data to conclude that project operation would not affect recreation resources, access, or travel along the lower river, because the information available on the level of use of this stretch of the river is limited, and no specific correlation is made in the ISR between such use, flow needs, and the changes in flows predicted by the flow and ice processes studies. Therefore, commenters request that the study area for studies 12.5 and 12.7 be extended downriver from the Parks Highway Bridge to Susitna Station (PRM 29.9). NPS states that baseline recreational use and access (including trails) should be studied but does not explain how. The Talkeetna Community Council states that intercept and mail surveys could be omitted for the lower river to minimize costs. Other commenters do not specify which elements of the studies should be conducted along the lower river.

Comments on Requested Study Modifications

AEA maintains that preliminary data from the Open Water Flow Routing Model) projects that the river stage in the reach from Willow Creek to Susitna Station would remain within the range of normal variation in summer, and therefore, project flows that could be 0.1 to 1.1 foot lower at Susitna Station would not affect river access or recreational use during normal summer operating conditions. Similarly, AEA maintains that the results of the Ice Processes Study (study 7.6) also indicate that ice conditions would be "within the range of normal variation" during winter operation of the project; thus, "Changes in ice formation and ice breakup in the lower river due to project-induced changes would not appreciably affect ice stability, safety, or water levels." Therefore, AEA concludes there would be no material effect on ice stability for recreation and river travel. AEA estimates the cost to extend study 12.5 to the lower river would be $1.6 million.

Discussion and Staff Recommendations

Available information indicates that significant use of the lower Susitna River, including seasonal boating and winter travel on the frozen river, occurs in the reach between Willow Creek and Susitna Station. While preliminary analyses suggest flow and ice conditions may be within the "normal range of variation," interpreting the effect of those flows and ice conditions on recreation access and travel could be misleading if only part of that flow range is usable by boaters or if the timing and duration of suitable ice conditions change. For example, the 1 foot lower river stage prevalent in summer under project operations could either enhance or degrade boat access. To complete that assessment, a better understanding of what flows are usable is needed.

Further modeling and integration of hydraulic, geomorphologic, ice processes, and aquatic and riparian studies (discussed elsewhere) are needed to better understand how project operation would affect river flow and ice conditions. Gathering more information on the present use of the lower river would allow us to determine whether such use could be adversely affected by project changes in flow and ice conditions

Therefore, we recommend that AEA (1) identify use and key locations for river recreation, access, and travel along the Susitna River from Parks Highway Bridge downstream to Susitna Station; (2) include users of this stretch of river in its planned interviews and focus group discussions to determine suitable flows and ice conditions for recreation and travel; and (3) assess availability of identified flows and ice conditions suitable for recreational use and travel in this reach in the USR. Participants should include those who can provide first-hand knowledge and site-specific observations of river use, access, and river conditions that may support or impede these activities. Because AEA plans to conduct focus group discussions and further interviews as part of study 12.7 and the Transportation Study (study 15.7), this effort should not increase costs and would provide information needed for our environmental analysis (section 5.9(b)(7).

Study 12.6 – Aesthetic Resources

Background

The purpose of the study is to document baseline aesthetic conditions and potential project effects on aesthetic resources within a primary study area (a 30-mile radius surrounding all project components) and a secondary, or "desktop," study area (generally enclosed by the Parks, Denali, Glenn, and Richardson Highways). Study objectives include: (1) assessing scenic quality attributes and visual sensitivity relative to visual distance zones; (2) conducting viewshed modeling and photo simulations for all project features (e.g., reservoir, roads, transmission lines); and (3) performing a four-season soundscape analysis.

Similar to studies 12.5 and 12.7, above, the lower Susitna River would be added to the study area if river flow, geomorphology, and ice studies indicate that effects on aesthetic resources are likely. AEA concludes that project operation would not materially affect aesthetic resources on the lower river, and therefore, the study area should not be extended below Parks Highway Bridge as discussed in the approved study plan.

Requested Study Modifications

The Nature Conservancy, NPS, and Rebecca Long recommend that the study area for study 12.6 be extended downriver from the Parks Highway Bridge to Susitna Station (PRM 29.9). They maintain that project operation could adversely affect aesthetic resources from changes to the river channels and riparian environment over time and changed ice conditions in winter. They do not believe that the ISR contains sufficient data to conclude that project operation would not affect aesthetic resources along the

lower river, given that other studies project a narrowing of the channels and migration of riparian vegetation.

Comments on Requested Study Modifications

Based on ISR results, AEA acknowledges that during project operation the river channel may narrow, and riparian vegetation may expand slightly in some areas as the channel adjusts to a narrower width over time; however, such changes are not uncharacteristic of a dynamic and changing floodplain. AEA states that the changes in river stage that have been modeled indicate that project operation would only minimally influence river flows, and that flows, sediment load, and ice cover would be within the range of normal variation experienced by users under existing, baseline conditions. Consequently, the basic channel form and character of the lower Susitna River as a wide, low-gradient, braided, and turbid river would remain, and changes to riparian habitat and wildlife, which are important to recreation, would be "extremely limited." AEA concludes that river uses are not expected to change, thus predominant viewer groups would not shift. AEA estimates that expanding the study area to the lower river would cost $130,000.

Discussion and Staff Recommendations

The natural aesthetic character of the lower river corridor (e.g., stage, geomorphology, extent of native plant communities) may change somewhat following project operation; however, these changes are predicted by other relevant studies to be within the normal range of variation and not out of character with the existing riverine environment. Once completed, studies should provide sufficient information to assess project effects on the aesthetic character of the lower river. The substantial expense of gathering additional data along the lower river would provide little or no benefit (5.9(b)(7)). Therefore, we do not recommend expanding the study area for study 12.6.

Study 15.6 – Social Conditions and Public Goods and Services Study

Background

The overall goal of this study is to assess potential changes in population, housing, public goods and services, and other quality of life factors resulting from the construction and operation of the project and potential changes in regional economic conditions resulting from the non-power effects of the project. Specifically, the study's goals are to: (1) describe existing socioeconomic conditions within the study area; (2) evaluate the effects of on-site manpower requirements; (3) estimate total worker payroll and material purchases during construction and operation; (4) evaluate the impact of any substantial immigration of people on governmental facilities and services and describe plans to address the impact on local infrastructure; (5) determine whether existing housing within the study area is sufficient to meet the needs of the additional population; (6) describe the

number and types of residences and businesses that might be displaced by project access road and transmission corridors; and (7) describe the effects of the proposed project on bio-physical attributes of the Susitna River system and what those changes might mean to commercial opportunities related to fishing, logging, agriculture, mining, and recreational activities, recreation and subsistence use values, quality of life, community use patterns, non-use environmental values, and social conditions of the area.

Add Communities of Willow and Skwentna to Study Report

Requested Study Modifications

The Willow Area Community Organization, Talkeetna Community Council, and Rebecca Long request that the Willow community be added to the study 15.6. The Nature Conservancy requests that the community of Skwentna also be included in the study.

Comments on Requested Study Modifications

AEA agrees to add Willow to the study area. It also indicated that it added Houston, Whittier, Wasilla, Seward, and Point MacKenzie as potentially affected communities because these communities are primary sources and destinations of project-related road and railroad traffic. However, AEA disagrees that Skwentna should be added to the study area because (1) The Nature Conservancy's requested modification fails to meet the criteria established in 18 CFR 5.15(d); and (2) Skwentna is not located along the Parks Highway or the Alaska Railroad Corporation line and is therefore unlikely to experience construction and transportation-related impacts associated with the project. AEA believes that any project effects likely to occur in the potentially affected communities in the study area would not be detectable in Skwentna because of its remote location.

Discussion and Staff Recommendation

The study area defined by AEA includes communities in the Denali and Matanuska-Susitna boroughs that may experience socioeconomic effects from the transportation and supply of construction materials and an increase in resident populations and demand for public services from the influx of construction workers.

It is unclear, however, how the proposed project would affect social conditions in Skwentna because it is located at least 20 miles west of the Susitna River corridor; is accessible only by boat, plane or snow machine; and is not within or near any primary travel corridors leading to the project area. Because The Nature Conservancy has not demonstrated a clear nexus between the project and social conditions in Skwentna (section 5.9(b)(5)), we do not recommend adding it to the study area as a potentially affected community.

Establish Non-Use Value of Undeveloped and Free Flowing River

Requested Study Modifications

The Hydropower Reform Coalition, The Nature Conservancy, and Rebecca Long state that AEA should conduct a national survey to establish the non-use values of the Susitna River in an undeveloped and free-flowing state. These entities assert that the Susitna River is one of the last free-flowing rivers in the country and should be studied to fully understand the benefits it provides to the American public.

Comments on Requested Study Modifications

AEA disagrees with the need to perform a national survey on the non-use benefits of an undeveloped Susitna River. To support its position, AEA cites a study by Hausman (2012) that shows a national online survey would be unlikely to produce statistically valid and unbiased non-use value estimates. AEA also states that significant challenges exist with quantifying non-use environmental values in dollar terms. AEA further states that quantifying these values is not necessary to characterize the effects of the proposed project on the Susitna River system because the value of the free-flowing Susitna River can be adequately assessed through the approved studies that establish a baseline for existing conditions. AEA points out that the Commission has already addressed non-use values under section 3.1 of its February 1, 2013, study plan determination where it determined that AEA should not be required to conduct a national-level economic valuation study.

Discussion and Staff Recommendation

The parties are essentially restating their initial request for a national survey. We addressed this request in the February 1, 2013 study determination. Nothing new has been added to the record to cause us to reconsider those findings. Therefore, for the reasons stated in our February 1, 2013 determination, we do not recommend AEA complete a national survey on the non-use benefits of an undeveloped Susitna River.

Study 15.7 – Transportation Resources Study

Background

The goal of this study is to assess current transportation conditions in the project area and evaluate potential project demands relative to current capacity limits and safety requirements for road, railroad, aviation, port, and river traffic. The approved study area encompasses the Railbelt area where regional economic impacts of the proposed project would be concentrated and includes regional travel corridors that extend from Anchorage to Fairbanks. The study considers relevant traffic sources, traffic nodes (points where travelers or shippers may select different routes), and destinations for each mode of transportation. AEA collected data on existing transportation infrastructure and traffic

levels along the Railbelt to assess the short-term (construction) and long-term (operational) direct and indirect impacts of the project and the cumulative impacts. The transportation effects of the proposed project (with-project) will be compared to existing conditions. Information to be collected on winter transportation use of the Susitna River from studies 12.7, 14.5, and 15.6 will be incorporated into study 15.7 once complete.

River Transportation Impacts to the Lower Susitna River from PRM 88.9 to 29.9, including the Willow Community and Deshka Landing

Requested Study Modifications

The Willow Area Community Organization, Talkeetna Community Council, and Rebecca Long request that the community of Willow be added to the study because the proposed project may influence river flows in a manner that could affect river travel conditions in the Willow area. The Talkeetna Community Council further requests that baseline conditions in the Willow/Lower Susitna area be documented from PRM 88.9 to 29.9 quantitatively, versus qualitatively as outlined in the current study plan, because this area hosts transportation barges servicing the Yentna and lower Susitna Rivers. The commenters also request that AEA evaluate project effects on winter oil and gas traffic and the use of the frozen river roads to access cabins and roads.

Comments on Requested Study Modifications

AEA states that the transportation study area includes facilities from the Port of Whittier to the Denali Highway, which includes Willow. AEA points out that the variety of transportation uses of the Susitna River will be addressed through interviews with individuals knowledgeable about river uses. AEA believes a quantitative analysis is not possible given the lack of consistently collected or reported data on river transportation uses. AEA also states that such an analysis is unnecessary because proposed project operations are unlikely to affect water levels in the Willow/lower Susitna area because any such project-related flow effects would be attenuated by the time the flows reach this area. AEA further indicates that the information it would collect on summer and winter transportation use by boats, barges, and snow machines through interviews with individuals knowledgeable about river transportation uses, including information on oil and gas ice roads and traditional trails, should be sufficient to assess project impacts on these uses.

Discussion and Staff Recommendation

AEA's assertion that there would be no effect on flows in the lower Susitna reach due to project operation is premature because final flow modeling studies are not yet complete. While preliminary modeling suggests that river flow and ice conditions in this reach of the river may be "within the normal range of variation," it is not known whether the river is accessible for transportation only within a portion of this "normal range" or

whether river access could be affected by any changes in the timing of flows. Further modeling, as well as data from other studies, are necessary before we can determine how project operation would affect river flow and ice conditions.

Available data indicates that the stretch of the Susitna River from Willow downstream to the Yentna River is a significant transportation resource, including in the winter when the river is frozen. Gathering data on the present use of the lower Susitna River in the Willow area, as recommended by the commenters, would be valuable in helping us to determine how any changes in river flow or ice processes would affect transportation access to the river in this area. As part of study 12.7, AEA proposes to interview river transportation users in the area around Deshka Landing downstream of Willow, but it does not specify the exact location of these interviews. Because Deshka Landing is a primary public access facility in this area, interviewing river users at this site would provide useful information to help characterize summer and winter transportation and recreational uses that changes in river flow could affect. Because AEA already proposes to conduct further interviews and focus group discussions, this information could be obtained at little additional cost and would inform the development of license requirements (section 5.9(b)(5)). Therefore, we recommend that interviews and focus group discussions include users of the lower Susitna River (RM 88.9 to 29.9), and in particular, users at Willow and Deshka Landing.

As noted in our recommendation for study 12.5 and 12.7, data obtained through interviews, focus group discussions, or other qualitative tools should be sufficient to describe river-related transportation, and would provide the necessary information to inform the development of license requirements (section 5.9(b)(4)).

Study 15.8 Health Impact Assessment Study

Background

The overall goal of this study is to analyze the effects of the proposed project on the health of residents in the study area. Specifically, the study's objectives are to: (1) identify potentially affected communities (PACs) and establish a community engagement plan; (2) identify public issues and concerns about how community health might be affected during construction and operation of the proposed project; (3) collect baseline health data at the state, borough, or census area level, tribal level, and at the PAC level; (4) identify data gaps in existing information and determine the most efficient method to fill those gaps through community consultation and coordination with other studies; (5) determine the nature and extent of potential project impact pathways; and (6) prepare a Health Impact Assessment report.

All communities that could potentially be affected by the construction and operation of the project are encompassed in the study area, including Cantwell and communities along the Alaska Railroad corridor, as well as communities that are located farther away but could be affected by the movement of workers, materials, and supplies.

The study area also includes communities identified in studies 15.5, 15.6, 15.7, 15.9, 14.5, and 12.5 because project effects on these resources could affect community health.

AEA will evaluate potential project-related health effects by considering the following Health Effects Categories (HECs): (1) social determinants (changes in social interactions, population, and employment); (2) transportation-related accidents and injuries; (3) exposure to potentially hazardous materials; (4) food, nutrition, and subsistence activity; (5) infectious disease; (6) water and sanitation; (7) non-communicable and chronic disease; and (8) health services infrastructure and capacity. A total of 43 communities will be evaluated in relation to these 8 HECs. Baseline health data has been collected at the state, regional, tribal, and community level but data gaps remain that are expected to be filled by results from the ongoing studies mentioned above.

Collect and Analyze Baseline Data for the Community of Willow

Requested Study Modifications

The Willow Area Community Organization, Talkeetna Community Council, , and Rebecca Long state that the Health Impact Assessment should be expanded to collect and analyze data specifically from the Willow area because they believe that project construction and operation would affect Willow because of its proximity to transportation corridors. They further request that food consumption, nutrition data, and community health observations be collected for Willow because this information has been collected for other communities as part of study 14.5 and will be used in the Health Impact Assessment.

Comments on Requested Study Modifications

AEA indicates that it is premature to determine at this time whether additional information needs to be collected for the Willow community because it is still in the process of evaluating the study communities in relation to all of the HECs and collecting baseline data from key stakeholder interviews to determine the nature and extent of potential project impacts on health. AEA acknowledges that the community of Willow is not included in the study area for study 14.5 but points out that the community is within the study area for study 15.7 because it could potentially experience some population change as a result of transportation effects and indirect growth from the proposed project.

Discussion and Staff Recommendation

The approved study plan does not specifically require AEA to collect baseline data on Willow or include Willow in the Health Impact Assessment; however, it does require AEA to identify PACs to be included in the assessment. AEA has identified Willow as a PAC and is evaluating it within the context of several HECs because of (1) its proximity

to the proposed project and transportation modes accessing the project; (2) its potential as a labor source for the project; (3) its potential as a source of accidents and injuries related to vehicle operation from the transport of project material on roads and railways as well as the changing distance of travel to subsistence resources; (4) its potential exposure to pollution from trucks moving project materials along transportation corridors; and (5) the potential for the project to affect food consumption/nutrition and subsistence activity related to the community. Since Willow has not been excluded from the study and further information is being developed, it is premature to require AEA to collect baseline health data for the community at this time. When more information becomes available, AEA may then need to collect additional data on Willow, depending on what the new information reveals. Therefore, we do not recommend AEA collect baseline health data on Willow at this time.

Study 15.9 – Air Quality

Background

The goal of the study is to assess existing air quality conditions in the project area and evaluate project effects on air quality. Study objectives include: (1) assessing current air quality conditions against state and national air quality standards; (2) summarizing existing air quality monitoring data; (3) determining attainment status of the study area (i.e., unclassifiable/attainment, non-attainment, maintenance); (4) quantifying short-term (construction) and long-term (operational) emissions; (5) comparing project emissions to the no-action alternative; (6) evaluating potential emission reductions from Railbelt fossil-fuel utility plants; and (7) identifying potential mitigation measures, if necessary, to reduce emissions during project construction

In 2013 and 2014, AEA: (1) documented existing conditions using meteorology, climate, and air quality monitoring data from nearby air monitoring and meteorological stations along with information it collected at the dam and two nearby sites; (2) qualitatively estimated project construction emissions; (3) summarized baseline fossil fuel emissions from Railbelt facilities; (4) qualitatively analyzed and compared emissions between no action and with the project; and (5) identified best management practices for reducing diesel exhaust emissions and controlling fugitive dust during construction activities.

Because project design had not progressed sufficiently to characterize the specific types and numbers of construction equipment; duration of activity; engine types; and specific levels of vehicle, aircraft, and rail operations, AEA did not conduct a quantitative air quality analysis as proposed in the study. AEA instead provided a qualitative analysis of project impacts on air quality and concluded that the project would not violate air quality standards. AEA proposes to conduct a quantitative analysis during the application phase of the project. AEA considers the study complete.

Proposed and Requested Study Modifications

Rebecca Long asserts that the study is incomplete because it does not include a quantitative analysis of air quality impacts as required in the study plan. Ms. Long recommends that AEA conduct a quantitative analysis that specifically estimates: greenhouse gas (GHG) emissions from decaying vegetation from the reservoir and from the melting of near-surface permafrost; emissions from cement manufacturing operations; the amount of GHG emissions that the project would displace based on new information provided by Chugach Electrical Association that shows a decline in residential energy use; and the exceedance of air quality standards in the winter due to inversions and fuel burning.

Comments on Requested Study Modifications

AEA asserts that the study objectives were met even though it could only qualitatively assess project emissions because project design had not progressed to a stage that would permit a more quantitative analysis.

AEA states that it provided data on permafrost melting in study 7.7 and study 4.5. Further, AEA indicates that it will provide GHG emissions and quantitatively analyze and address cement manufacturing emissions if a concrete batch plant is proposed in its license application. AEA does not believe a reevaluation of baseline fossil fuel generation emissions based on recent residential demands is necessary because the analysis examined long-term trends in fuel generation emissions. AEA explains that it does not anticipate any changes in generation emissions in the short term because the large investments made in major power generation facilities react slowly to changing conditions; therefore, its long-term assessment more accurately reflects fuel generation emissions that might be offset by the project. AEA does not respond to Ms. Long's assertion that the analysis should consider how project emissions would affect air quality during winter when inversion layers are heavily laden from fossil fuel burning.

Discussion and Staff Recommendations

The approved study plan does not require AEA to assess GHG emissions from the decay of vegetation in the proposed reservoir or permafrost melting in the project area because we found existing information sufficient to assess project effects on GHG emissions. Nothing in Ms. Long's filing makes us reconsider our findings; therefore, no modifications to the study plan to address these effects are recommended. AEA's proposal to examine long-term energy use trends to determine the amount of GHG emissions that the project would displace is reasonable for the reasons explained by AEA; therefore, no modification to the study plan is warranted.

We do agree with Ms. Long, however, that it is premature for AEA to determine that the project would not "violate" national air quality standards or state of Alaska air quality standards based only on a qualitative analysis. While the study report for study

15.9 shows that existing ambient air quality in the project area appears to be consistent with parameters specified by federal and state standards, AEA does not provide sufficient information to support its claim that air quality would continue to do so during project construction and operation, particularly during winter months when air quality conditions are most affected by wood burning. Therefore, we recommend AEA quantify the expected emissions during construction and operation as currently required by the approved study plan. However, such analysis can only be done when project design and material needs are better defined. Therefore, AEA should include in its license application a quantitative analysis of project impacts on air quality, especially during the winter months when inversion layers are common.

APPENDIX C

STAFF'S RECOMMENDATIONS ON REQUESTED NEW STUDIES

New Study Request: Terrestrial Invertebrates

Requested New Study

Copper Country Alliance (CCA) requests AEA conduct a new study on terrestrial invertebrates. The goals of the new study would be to: (1) determine what species of terrestrial invertebrates exist in and near the area that would be dammed and which, if any, rare or potentially endemic terrestrial invertebrate species are present; (2) identify which species are most important as food for bats, birds, and wood frogs; (3) identify which species are most important as pollinators for willows; and (4) identify which species are most important in decomposing plant and animal remains. CCA's recommended study methods include literature searches and field sampling using appropriate methods within the area of the proposed lake and a 2-mile buffer of the inundation area. CCA notes that current studies provide little information about terrestrial invertebrates and that the Alaska Wildlife Action Plan identifies five orders of terrestrial invertebrates as species of greatest conservation need. Rebecca Long also supports this request.

Comments on Requested New Study

AEA states that the Commission does not routinely evaluate terrestrial invertebrates in the licensing process; hence, the lack of a specific study cannot be characterized realistically as a major data gap. AEA adds that it is highly unlikely that construction of the project would cause significant or detectable effects on the regional occurrence or abundance of terrestrial invertebrates. AEA notes that while the Alaska Wildlife Action Plan includes the orders Hymenoptera, Diptera, Odonata, Lepidoptera, and Arachnida in the list of species of greatest conservation need, on the basis that they are economically and ecologically important, the plan does not provide any detailed discussion of these taxa. Consequently, the plan's designation of entire orders of animals (rather than species, genera, or even families) reflects an extremely broad approach to identifying "species" of conservation need, further underscoring the general lack of knowledge about how to monitor these taxa.

Discussion and Staff Recommendation

We agree with AEA that it is highly unlikely that construction of the project would cause significant or detectable effects on the regional occurrence or abundance of terrestrial invertebrates. Therefore, it's unclear how the information would be used to inform the development of license conditions (section 5.9(b)(5). In addition, implementing a study to identify all terrestrial invertebrate species in the study area

would be a monumental task (section 5.9(b)(6). Therefore, we do not recommend that AEA conduct a site-specific terrestrial invertebrate study.

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