FEDERAL ENERGY REGULATORY COMMISSION
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OFFICE OF ENERGY PROJECTS

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

Wayne Dyok
Susitna-Watana Project Manager
Alaska Energy Authority
813 West Northern Lights Boulevard
Anchorage, AK 99503

Reference: Study Plan Determination on 14 remaining studies for the Susitna-Watana Hydroelectric Project

Dear Mr. Dyok:

Pursuant to 18 C.F.R. § 5.13(c) of the Commission's regulations, this letter contains the study plan determination for the14 remaining studies for the Susitna-Watana Hydroelectric Project No. 14241 (Susitna-Watana Project or project). The determination is based on the study criteria set forth in section 5.9(b) of the Commission's regulations, applicable law, Commission policy and practice, and the record of information.

Background

On July 16, 2012, Alaska Energy Authority (AEA) filed its proposed plan for 58 studies covering geologic and soil resources, water quality, geomorphology, hydrology, instream flow, fish and aquatic resources, wildlife resources, botanical resources, recreation and aesthetic resources, cultural and paleontological resources, subsistence resources, socioeconomic and transportation resources, and project safety in support of its intent to license the project. AEA filed its revised study plan on December 14, 2012.

On February 1, 2013, Commission staff issued its study determination for 44 of the 58 studies, approving 31 studies as filed and 13 with modifications. A decision on the remaining 14 studies was deferred until AEA filed additional information and held meetings with stakeholders to discuss the new information. AEA held stakeholder meetings on February 14 and 15 to discuss drafts of the additional information requested by Commission staff, and filed the additional information on March 1 in accordance with the Commission-approved schedule. On March 4, 7, and 26, 2013, AEA also filed reports on baseline studies it voluntarily collected during the 2012 study season.

Comments on the 14 studies were filed by the Coalition for Susitna Dam Alternatives, U.S. Fish and Wildlife Service (FWS), Nature Conservancy of Alaska (TNC), Environmental Protection Agency, Center for Water Advocacy, Southcentral Alaska Subsistence Regional Advisory Council, National Marine Fisheries Service (NMFS), Center for Biological Diversity, Talkeetna Community Council, Natural Resources Defense Council, and four individuals.

General Comments

A number of the comments received do not address study plan issues, but rather address the need for the project and concerns about the licensing process. This determination does not address these comments, but only addresses comments on the merits of the 14 remaining studies submitted pursuant to section 5.13 of the Commission's regulations and comments received thereon. This study determination also does not address comments on the studies approved in the February 1 study plan determination.[1]

Study Plan Determination

Of the 14 studies contained in AEA's revised study plan, 13 are approved with staff-recommended modifications and 1 is approved as filed by AEA (see Appendix A). The specific modifications to the study plan and the bases for modifying AEA's study plan are explained in Appendix B. Commission staff considered all study plan criteria in section 5.9 of the Commission's regulations; however, only the specific study criteria that are particularly relevant to the determination are referenced in Appendix B.

Nothing in this study plan determination is intended, in any way, to limit any agency's proper exercise of its independent statutory authority to require additional studies. In addition, AEA may choose to conduct any study not specifically required herein that it feels would add pertinent information to the record.

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[1] For example, the Southcentral Alaska Subsistence Regional Advisory Council expressed concerns about the need for an analysis of project effects on subsistence uses. The February 1 study determination letter approved AEA's Subsistence Resources Study (14.5), which should address the Council's concerns. Similarly, several entities again expressed the need to evaluate the effects of climate change on the resources of the Susitna River basin and project operations, which was addressed in the February 1, 2013, study determination.

If you have any questions, please contact Matt Cutlip at (503) 552-2762.

Sincerely,

Jeff C. Wright
Director
Office of Energy Projects

Enclosures: Appendix A--Approved and modified studies subject to this determination
Appendix B--Staff's recommendations on proposed and requested studies

cc: Mailing List
Public Files

Susitna-Watana Project
No. 14241-000

APPENDIX A
Approved and Modified Studies Subject to This Determination

Study	Recommending Entity	Approved	Approved with Modification	Not Required
(1) Baseline Water Quality Study (study 5.5)	AEA		X	
(2) Water Quality Modeling Study (study 5.6)	AEA		X	
(3) Mercury Assessment and Potential for Bioaccumulation Study (study 5.7)	AEA		X	
(4) Geomorphology (study 6.5)	AEA	X		
(5) Fluvial Geomorphology Modeling Below Watana Dam Study (study 6.6)	AEA		X	
(6) Groundwater Study (study 7.5)	AEA		X	
(7) Ice Processes in Susitna River Study (study 7.6)	AEA		X	
(8) Fish and Aquatics Instream Flow Study (study 8.5)	AEA		X	
(9) Riparian Instream Flow Study (study 8.6)	AEA		X	

Study	Recommending Entity	Approved	Approved with Modification	Not Required
(10) Study of Fish Distribution and Abundance in the Upper Susitna River (study 9.5)	AEA		X	
(11) Study of Fish Distribution and Abundance in the Middle and Lower Susitna River (study 9.6)	AEA		X	
(12) River Productivity (study 9.8)	AEA		X	
(13) Characterization and Mapping of Aquatic Habitats (study 9.9)	AEA		X	
(14) Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam (Study 11.6)	AEA		X	

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APPENDIX B
Staff Recommendations on Proposed and Requested Studies

The following discusses 14 of the studies contained in AEA's revised study plan (RSP), filed on December 14, 2012, as supplemented by its March 1 filing, and the comments thereon.[2] Staff's bases for recommending or not recommending certain modifications to the study plan are discussed below. We first address several overarching comments related to study duration and study integration, and then follow with a discussion of specific comments filed on the revised study plan.

Schedule, Study Duration, and Geographic Scope

Applicant's Proposed Study

The Revised Study Plan (RSP) includes a proposed schedule for all prefiling field studies and modeling efforts to be completed over a two-year period in 2013 and 2014.

Comments on the Study

The National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (FWS), and numerous individuals and non-governmental organizations (NGOs) state their concern that two years of sampling of biotic communities and the physical processes affecting those communities are insufficient to capture the natural variability of the system, collect adequate site-specific data, and build models that would predict how project operation would affect community relationships. Furthermore, proposed changes to the sampling strategies may occur following one year of study, making year-to-year comparisons of data difficult. The commenters again request that the Commission recognize the importance of the temporal and spatial scale of these studies and the need to account for unforeseen circumstances to gather the needed data. The agencies and commenters requested a minimum of five years for all studies related to anadromous fisheries resources to coincide with the average lifespan of a Chinook salmon and to account for a substantial range of environmental variability.

Discussion and Staff Recommendation

AEA's proposed two-year study schedule is consistent with generally accepted practices in the scientific community for evaluating the effects of hydropower projects on

[2] These studies include 5.5, 5.6, 5.7, 6.5, 6.6, 7.5, 7.6, 8.5, 8.6, 9.5, 9.6, 9.8, 9.9, and 11.6.

fisheries and riparian resources (section 5.9(b)(6)). Therefore, it would be premature to require additional years of data collection without first evaluating the data and modeling results that will be obtained from the 2013 and 2014 study seasons. The need to conduct additional years of studies will be determined on a case by case basis for each study. The type of information that we would consider in determining the need for additional years of studies would include, but not necessarily be limited to, whether: (1) the study objectives were met during the two-year study period, (2) there was substantial variability in study results between study years, (3) the study was implemented under anomalous environmental conditions, and (4) the data collected are sufficient to conduct the environmental analysis pursuant to NEPA and inform the development of license requirements. All stakeholders will have the opportunity to request additional years of data collection following the 2013 and 2014 study seasons after reviewing the initial and updated study reports, and upon a showing of good cause as specified in sections 5.15(d) and 5.15(e) of the Commission's regulations. Moreover, the integrated licensing process (ILP) regulations specifically contemplate the potential need for modifying or conducting additional studies if the studies were conducted under anomalous conditions or if environmental conditions changed in a material way (section 5.15(d)). Therefore, no modifications to the study plan are recommended.

Study Plan Integration

Applicant's Proposed Study

The RSP includes the development of various models to predict resource (e.g., aquatic habitat, sediment transport and deposition, water quality, and riparian vegetation establishment and survival) responses to project operations. For each study, AEA conceptually characterizes the interdependencies of the various studies, including which studies would provide inputs to the other studies.

AEA proposes to develop a decision support system to evaluate project effects on Susitna River environmental resources under various alternative operating scenarios. The decision support system would be used to focus attention on those attributes that the technical working group (TWG) believes are the highest priority in evaluating the relative desirability of alternative scenarios with respect to natural resources. Evaluation indicators selected for a decision support system type-matrix represent a preliminary analysis to identify the most promising scenarios. When discussion of alternatives focuses on only a few remaining scenarios, those final scenarios would be evaluated using the larger data set of habitat indicators to ensure that environmental effects are consistent with the initial analyses.

Indicator variables would be selected in collaboration with the TWG. The decision support system and supporting software would be initiated in collaboration with the TWG after the initial results of the various habitat modeling efforts are available in 2014. AEA intends to develop the decision support system by early 2015 to assist in evaluating various operating scenarios for completion of the license application.

Comments on the Study

FWS, NMFS, the Environmental Protection Agency (EPA), and the Coalition for Susitna Dam Alternatives (CSDA) assert that AEA's proposed study plan does not adequately describe how field data, models, and assumptions from individual will be integrated to produce a set of metrics to support a comparison of alternatives. NMFS and FWS also acknowledge that it is difficult to select such metrics until the results of proposed studies are completed, but that "the overall high quality the proposed individual studies, the individuals and organizations involved and the aggregate level of effort suggest that meaningful synthesis and evaluation variables can be produced." NMFS and FWS are principally concerned that such integration is done and that it is done in concert with the agencies. FWS recommends an early (between 2013-2014 field season) effort to identify specific metrics that would be used to compare alternatives to help shape the ultimate integrated analysis and further guide coordination among studies and modifications to field work.

The Nature Conservancy (TNC) and The Natural Resources Defense Council (NRDC) recommend that all studies be evaluated for project operation scenarios that include baseline (no project), the proposed load following, various base load operations, and run-of-river operation. TNC states that a run-of-river scenario would allow assessment of the project on water quality, sediment transport and other anticipated effects.

Discussion and Staff Recommendation

AEA proposes a reasonable, phased, and iterative approach and schedule for selecting and applying various study-specific models, developing model parameters, and reporting results within each study. AEA's approach includes TWG involvement and is consistent with generally accepted practice for complex interdisciplinary studies.

AEA intends to evaluate various operating scenarios selected in consultation with the TWG. However, its current proposal only includes three with-project operating scenarios: (1) maximum load-following; (2) intermediate load-following; and (3) base load. While AEA's proposed operating scenarios are too narrowly defined at this time, it is premature to define all possible operating scenarios until some data results are gathered and vetted. The no-action alternative is the baseline the Commission uses to evaluate all alternatives; therefore, it must be evaluated. We also recommend that AEA evaluate a run-of-river base load operation for the reasons cited by TNC.

Baseline Water Quality (5.5)

Applicant's Proposed Study

AEA proposes to conduct a study to establish baseline water quality conditions in the Susitna River that would inform an assessment of the anticipated effects of the proposed project on water quality in the Susitna River Basin. The study would document historical water quality data and provide additional stream temperature, meteorological, general surface water quality, metals, and bacterial data within and downstream of the proposed project area. Data would be used to assess current conditions, calibrate a predictive water quality model, and assess presence and potential impacts of toxics on aquatic life that may result from the proposed project.

AEA proposes the following specific study objectives.

- Document historical water quality data and combine it with data generated from this study for use in Study 5.6 (water quality modeling) to predict project effects under various operating scenarios.

- Collect 3 years (2012-2015) of stream temperature and meteorological data to augment the existing data.

- Characterize surface water physical, chemical, and bacterial conditions in the Susitna River within and downstream of the proposed project area.

- Measure baseline metals concentrations in sediment and fish tissue for comparison to State of Alaska criteria.

- Perform a pilot thermal imaging assessment of a portion of the Susitna River between Talkeetna and Devils Canyon to document thermal refugia. If the pilot assessment is successful, it may be expanded to document other thermal refugia in the project area.

The study area for water quality monitoring includes the Susitna River from river mile (RM) 15.1 to RM 233.4, tributaries that contribute large portions of the Lower River flow (i.e., Talkeetna, Chulitna, Deshka, and Yentna rivers), and smaller tributaries that represent important spawning and rearing habitat for anadromous and resident fisheries (i.e., Gold, Portage, Tsusena, and Watana creeks, and the Oshetna River).

Continuous meteorological data would be collected at three new and three existing sites from July 2012 through 2015. The meteorological (MET) stations would collect air temperature, relative humidity, barometric pressure, precipitation, wind speed, direction, and solar degree days at stations representing river conditions and conditions near the dam site above the projected elevation of the reservoir pool.

Baseline water quality monitoring[3] would be conducted at eight mainstem Susitna River monitoring sites located downstream of the proposed dam, two mainstem sites upstream of the proposed dam, four major tributaries to the Susitna River, including the Talkeetna, Chulitna, Deshka, and Yentna rivers, and three smaller tributaries that represent important spawning and rearing habitat for anadromous and resident fisheries, including Gold Creek, Indian River, and Portage Creek. These sites would be monitored monthly from June to September, once in December, and once in March for one year (2013). This monitoring period was selected to capture the beginning of ice break-up (June), the open-water period, the beginning of ice formation (September), and two winter sampling events (December, March). Baseline water quality data would be collected from surface water, sediment, and fish tissue.

Continuous stream temperature monitoring would be conducted from July 2012 through September 2014 at 39 total sites (22 mainstem sites, 11 tributary sites, and 6 slough[4] sites). Seventeen of the 39 continuous stream temperature monitoring sites would overlap with baseline water quality monitoring sites. The measured water quality parameters and metals[5] would be used to calibrate a water quality model for the project

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[3] The water quality parameters that would be monitored are dissolved oxygen (DO), pH, water temperature, specific conductance, turbidity, redox potential, color, hardness, alkalinity, nitrate/nitrite, ammonia, total Kjeldahl nitrogen, total phosphorus, ortho-phosphate, chlorophyll-a, total dissolved solids (TDS), total suspended solids (TSS), and dissolved organic carbon (DOC).

[4] The sloughs represent a combination of physical conditions found in the basin that are known to support important fish-rearing habitat.

[5] The metals that would be monitored are arsenic, barium, beryllium, cadmium, cobalt, copper, iron, lead, manganese, magnesium, mercury, molybdenum, nickel, thallium, and vanadium.

representing both a riverine and reservoir environment as described in Study 5.6 (water quality modeling).

In coordination with Study 8.5 (fish and aquatics instream flow), and in addition to the baseline water quality monitoring of the 10 mainstem sites discussed above, water quality would also be monitored in 10 focus areas every 2 weeks for a total duration of 6 weeks. Focus area water quality monitoring would be at a relatively higher resolution, along transects spaced between 100 and 500 meters apart (longitudinally), and at 3 to 5 collection points along each transect.

In addition, a single baseline screening survey would be conducted during late summer 2013 for an expanded set of parameters. This single screening survey would be conducted to measure:

- five additional general water quality parameters (residues, total organic carbon [TOC], fecal coliform, petroleum hydrocarbons, and radioactivity);
- three additional dissolved metals in the water column (aluminum, chromium [III & IV], and selenium);
- eight metals in sediments (aluminum, arsenic, cadmium, copper, iron, lead, mercury, and zinc); and
- four metals and one organo-metal in fish tissue (mercury, methylmercury, arsenic, cadmium, and selenium).

AEA also proposes to conduct a pilot thermal imaging assessment using a portion of Susitna River thermal imagery, between Talkeetna and Devils Canyon, collected in October 2012. The pilot assessment would ground truth the existing thermal imagery data by using continuous temperature monitoring data from buoy systems and bank installation equipment employed for the 2012 temperature monitoring study. In coordination with the instream flow and fish studies, AEA would then evaluate whether the thermal imaging data are applicable and whether or not additional thermal imagery collection during the 2013 field season to characterize river temperature conditions would be fruitful.

Groundwater quality would be characterized by comparing basic water quality (i.e., temperature, DO, conductivity, pH, turbidity, and oxidation-reduction [redox] potential) in key productive aquatic habitat types (three to five sites) to that of non-productive habitat types (three to five sites). The sites would be co-located within the focus areas to measure groundwater input and influence on surface water chemistry.

AEA prepared a Baseline Water Quality Study Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) providing for data quality assurance and sampling quality control measures.

Comments on the Study

Standard Operating Procedures (SAP) and Quality Assurance Project Plan (QAPP)

Alaska DNR recommends that AEA develop a SAP/QAPP that meets state standards.

NMFS and FWS request an explicit discussion and development of standard operating protocols (SOPs) for field sampling low-level mercury concentrations ("Clean Hands/Dirty Hands") to limit sample contamination during collection, shipping, and handling.

Discussion and Staff Recommendation

AEA developed a separate SAP/QAPP for Study 5.5 (baseline water quality), Study 5.6 (water quality modeling), and Study 5.7 (mercury bioaccumulation). While the Study 5.5 and Study 5.7 SAP/QAPPs provide some detailed methodology and analysis related to mercury, they are not fully consistent with generally accepted practices in the scientific community (section 5.9 (b)(6)) as noted by NMFS and FWS. Specifically, the analytical methods for mercury identified by AEA are incorrectly stated in the SAP/QAPPs. AEA states it would use EPA Method 7470A to analyze total and dissolved mercury in water, EPA Method 245.5/7470A to analyze total mercury in sediments, EPA Method 1631 to analyze total mercury in fish tissue, and EPA Method 1631 to analyze methylmercury in fish tissue.

However, the appropriate analytical methods (section 5.9(b)(6)) for determination of total mercury in water, sediments, and fish tissue are stated in EPA Method 1631E, and for determination of methylmercury in water and fish tissue are stated in EPA Method 1630, and are not proposed by AEA. Both of these methods are accompanied by Method 1669 (Clean Hands/Dirty Hands) and would preclude contamination of low-level mercury concentrations during the sampling process as requested by NMFS and FWS. Developing a SAP/QAPP that is consistent with Alaska DNR's standards would ensure that AEA employs the appropriate methods and sample protocols for each of its water quality studies, to support the collection of quality data. We note that the appropriate laboratory analytical methods require the use of EPA's Method 1669 for all mercury field sampling and as such would only marginally increase the costs associated with the study (we estimate $500 - $1,000) but would assure the integrity and quality of the data collected (sections 5.9(b)(6) and (7)).

We recommend that AEA employ EPA Method 1631E for laboratory analysis of total mercury in water, sediments, and fish tissue, and EPA Method 1630 for laboratory analysis of methylmercury in water and fish tissue. We recommend that AEA apply Method 1669 (Clean Hands/Dirty Hands) for all mercury field sampling.

Evaluation of Baseline Mercury Measurements in Water

NMFS and FWS state that Toxicity Reference Values (TRVs) are not included as a component of determining the need for additional baseline sample collection in Study 5.5. However, the agencies recognize that Study 5.7 (mercury assessment) does incorporate TRVs for assessing the potential impacts of the project on mercury in specific species of piscivorous birds and aquatic furbearers.

Discussion and Staff Recommendation

AEA's proposed study does not specifically state that AEA would use TRVs to assess baseline water quality results. Rather it states that it would compare water quality results to Alaska water quality standards and SQuiRT values.[6] However, according to Study 5.7 (RSP section 5.7.4.6), AEA would use TRVs for the evaluation of mercury concentrations in surface waters.

Using TRVs as a component of determining the need for additional baseline water quality sampling, as requested by NMFS and FWS, and as suggested by AEA is appropriate because TRVs have been developed by EPA for the protection of various species from contaminants in surface water and can provide an additional set of information that would aid in the determination on the need for additional baseline water quality data (section 5.9(b)(6)). This would be a relatively low cost measure because AEA is already proposing to use TRVs as part of their analysis in Study 5.7 (mercury assessment.

We recommend that AEA utilize the TRVs as an additional benchmark when evaluating the need for additional baseline water quality data collection.

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[6] The National Oceanic and Atmospheric Administration compiled the Screening Quick Reference Tables, or SQuiRTs, to help evaluate potential risks from inorganic and organic contaminants in water, sediment, or soil.

Additional Water Quality Monitoring Sites in the Lower River

NMFS requests that water quality monitoring occur at additional Lower River fish sampling sites including six tributary mouths that capture both moderately sloped "brown water and clear water" streams (i.e., Montana Creek, Sheep Creek [or Kashwitna], Willow Creek, Deshka River [aka Kroto Creek], Rabideux Creek, and Trapper Creek [or Birch Creek]). NMFS requests that water quality monitoring also occur at six side sloughs and six upland sloughs in areas adjacent to these tributary and mainstem sampling locations. NMFS states that the water quality sample parameters should include the subset of measures proposed by AEA for the focus areas, but also include turbidity, alkalinity, ammonia-nitrogen, dissolved organic carbon (DOC), and total and dissolved copper.

Discussion and Staff Recommendation

The description of Lower River studies and study sites is provided in the final 2013 focus area and study site selection technical memorandum filed on March 1, 2013. For the water quality study, the following information would be collected to characterize the Lower River at six mainstem and four tributary sites: stream temperature and meteorological data; physical, chemical, and bacterial surface water conditions; baseline metals concentrations in sediment and fish tissue; groundwater inflow and potential thermal refugia; and, historical water quality data. NMFS does not provide sufficient information in its comments to justify why AEA's proposal to collect the aforementioned water quality data at six mainstem and four tributary sites in the Lower River is inadequate or why the additional requested information would be needed (section 5.9(b)(7)) to adequately describe the existing environment and evaluate project effects (section 5.9(b)(5)). AEA anticipates that project effects would be largely attenuated in the Lower River and proposes to collect data and conduct water quality modeling in the Lower River in 2013 to establish whether or not additional information is necessary to evaluate potential project effects. Given the uncertainties of the project effects on the Lower River, we consider AEA's phased approach to be valid and consistent with generally accepted scientific practices (section 5.9(b)(6)).

No modifications to the study plan are recommended.

Water Quality in Macrohabitats at Focus Areas

NMFS requests that water quality sampling in focus areas explicitly include designated sites representing tributary mouth, side slough, and upland slough macrohabitats. NMFS states that macrohabitat sampling at the focus areas should include additional water quality parameters beyond the set proposed by AEA, namely alkalinity, ammonia-nitrogen, DOC, and total and dissolved copper. Additionally, NMFS requests that in situ parameters (i.e., DO, temperature, specific conductivity, pH, turbidity) be measured at 10- to 20-meter intervals extending from the mainstem upstream into a designated tributary or slough macrohabitats until no evidence of mainstem water quality influence is observed.

Discussion and Staff Recommendation

AEA proposes to collect and model the requested additional water quality parameters (i.e., alkalinity, ammonia-nitrogen, DOC, and total and dissolved copper) at 17 sites that include mainstem, tributary, and slough habitats as part of Study 5.5 (baseline water quality) and Study 5.6 (water quality modeling). NMFS does not provide any information in their comment to explain why AEA's proposal to collect and model water quality data at these 17 sites is inadequate (section 5.9(b)(7)) or why the requested additional data collection at the 10 focus area sites is needed to meet the study objectives or evaluate project effects (section 5.9(b)(5)).

Regarding NMFS' request to collect in situ water quality samples at 10 to 20-meter intervals from the mainstem upstream into designated tributaries, we assume that NMFS is interested in delineating the upstream extent of the mainstem's influence on tributary water quality. However, the extent of backwater effects, and therefore water quality effects, of the mainstem on tributary streams is being modeled by AEA in Study 8.5 (fish and aquatics instream flow). Additionally, as mentioned above, water quality within slough habitat and tributary mouths will be modeled in Study 5.5 (baseline water quality). Therefore, the delineation information NMFS seeks may be discerned from the results of Study 8.5 (fish and aquatics instream flow) and information on water quality at tributary mouths and slough habitats would be made available through the environmental fluid dynamics code (EFDC) model developed through Study 5.6.

No modifications to the study plan are recommended.

Ammonia Nitrogen and Ortho-Phosphorus Methods

NMFS states that the method detection limits (MDLs) identified in Table 5.5-3 of AEA's RSP for ortho-phosphate and ammonia-N are too high and would not allow for evaluation of nutrient limitations. For ammonia-N, NMFS requests AEA use an MDL of 5.0 ug/L, citing EPA Method 350.1 (Rev. 2.0). For total dissolved and ortho-phosphorus, NMFS request that an MDL of 1.0 ug/L, be adopted, citing SM 4500-P.

Discussion and Staff Recommendation

The minimum attainable MDL for ammonia-N utilizing EPA Method 350.1 (Rev. 2.0) is 10 ug/L.[7, 8] For total dissolved and ortho-phosphorus utilizing SM 4500-P is 10 ug/L.[9] As a result, the MDLs requested by NMFS (5.0 ug/L and 1.0 ug/L, respectively) appear to be in error. In addition, AEA already proposes to use EPA Method 350.1 (Rev. 2.0) for determination of ammonia-N, which is consistent with NMFS' request; however, AEA also mis-identified the MDL for ammonia-N, reporting it as 31 ug/L. In any event, the method for ammonia-N analysis requested by NMFS and proposed by AEA is the same, and the method detection limit is specified within EPA Method 350.1 (Rev 2.0).

Finally, while AEA does not propose to use SM 4500-P as an analytical method for detecting total dissolved and ortho-phosphorus, AEA is proposing to use EPA Method 365.3. EPA Method 365.3[10] does identify the MDL for total dissolved and ortho-phosphorus utilizing to be10 ug/L, the same as SM 4500-P.

No modifications to the study plan are recommended.

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[7] EPA. 1993. Method 350.1 Determination of Ammonia Nitrogen By Semi-Automated Colorimetry, Revision 2.0. U.S. Environmental Protection Agency. Environmental Monitoring Systems Laboratory, Office of Research and Development. August 1993.

[8] EPA. 1993. Method 350.1 Determination of Ammonia Nitrogen By Semi-Automated Colorimetry, Revision 2.0. U.S. Environmental Protection Agency. Environmental Monitoring Systems Laboratory, Office of Research and Development. August 1993.

[9] American Public Health Association, American Water Works Association, and Water Environment Federation. 2012. Standard Methods for the Examination of Water & Wastewater, 22nd Edition. American Public Health Association, Washington, D.C. http://www.standardmethods.org/

[10] EPA. 1983. Methods for the Chemical Analysis of Water and Wastes (MCAWW). Environmental Monitoring Systems Laboratory, Office of Research and Development. March 1983. EPA/600/4-79/020.

Water Quality Modeling Study (5.6)

Applicant's Proposed Study

AEA proposes to use the information collected in Study 5.5 (baseline water quality) to develop a primary water quality model and multiple secondary water quality models to evaluate the potential effects of proposed project construction and operation on various physical and chemical water quality parameters in the project area.

Under its proposed study, AEA would implement the following specific study objectives:

- Develop and implement a reservoir and river water temperature model for use with past and current monitoring data.
- Model water quality conditions in the proposed reservoir, including, but not necessarily limited to, water temperature, DO, suspended sediment, turbidity, chlorophyll-a, nutrients, ice (in coordination with Study 7.6 (ice processes)), and metals.
- Model water quality conditions in the Susitna River from the proposed dam site downstream, including, but not necessarily limited to, water temperature, suspended sediment, turbidity, and ice processes (in coordination with Study 7.6 (ice processes)).

The study area includes the Susitna River from RMs 15.1 to 233.4, as well as tributaries that contribute large portions of the Lower River flow (i.e., Talkeetna, Chulitna, Deshka, and Yentna rivers), and smaller tributaries that represent important spawning and rearing habitat for anadromous and resident fisheries (i.e., Gold, Portage, Tsusena, and Watana Creeks, and the Oshetna River).

AEA proposes to use the Environmental Fluid Dynamics Code (EFDC), a three-dimensional coupled hydrodynamic and water quality model to implement its primary modeling approach.

Specifically, AEA's primary water quality modeling approach would include the following elements:

- Model the Susitna River upstream, within, and downstream of the proposed reservoir location under (1) the initial (i.e., baseline) condition in the absence of the proposed dam, and (2) within the proposed reservoir.

- Simulate conditions within the proposed reservoir including flow circulation, turbulence mixing, temperature dynamics, nutrient fate and transport, interaction between nutrients and algae, sediment transport, and metals transport.

- Simulate water column stratification within the proposed reservoir during the warm season and de-stratification when air temperatures cool down.

- Calibrate for the conditions within the proposed reservoir utilizing a literature survey of parameterization schemes for EFDC.

- Develop an uncertainty analysis to account for the lack of in situ reservoir calibration data, to enhance the reliability of reservoir model predictions.

- Simulate riverine conditions using channel topography and flow data at select locations and under various project operating scenarios, including load-following.

- Predict riverine water quality conditions at a longitudinal resolution between 250 meters and 1 kilometer.

- Predict riverine water quality conditions at a relatively finer scale of resolution for the 10 focus areas to determine habitat suitability for life stages of select fish species under each of the operating scenarios.

- Calibrate and validate riverine conditions using available data from Study 5.5 (baseline water quality).

- Predict water quality conditions established by project operations that promote methylation of bioavailable mercury by location and intensity in both riverine and reservoir habitats. This includes modeling mercury concentrations in dissolved and methylated forms.

- Predict water quality conditions established by project operations that affect other metals in both riverine and reservoir habitats, if significant concentrations of metals are identified in surface water and sediment as part of Study 5.5 (baseline water quality).

- Conduct water temperature modeling and routing of fluctuating flows immediately prior to and during ice cover development with a separate thermodynamics-based ice processes model developed as part of Study 7.6 (ice processes).

- AEA also proposes to develop and implement the following secondary water quality models to address mercury in reservoir fish tissue and potential metal toxicity as a result of project construction and operation.

- Harris and Hutchinson (2008) Model – this model would be used as an initial screening tool to predict peak mercury concentrations in piscivorous and non-piscivorous fish tissue after filling of the proposed reservoir.

- Phosphorus Release Model – this model would be used as a more sophisticated approach to predicting peak mercury concentrations in piscivorous and non-piscivorous fish tissue after filling of the reservoir, as well as the timing of peak concentrations.

- Biotic Ligand Model – this model would predict the potential toxicity of copper, silver, cadmium, zinc, nickel, and lead to aquatic life if water quality monitoring in 2012-2013 or EFDC model results indicate that these metals are or would be mobilized at levels of concern.

Comments on the Study

Calibration of the Hydrodynamic Model Component of EFDC

FWS requests that the water quality model calibration process explicitly include the calibration of underlying hydrodynamic features such as water level and flow velocity, and that the hydrodynamic calibration occur prior to the calibration of water quality parameters.

Discussion and Staff Recommendation

AEA's proposed EFDC model includes a hydrodynamic model as one of four modeling components; the other three being water quality, sediment transport, and toxics. The hydrodynamics (i.e., motion) of water and corresponding changes in its properties (e.g., water temperature, salinity) affect other aspects of water quality. For this reason, the reliability of the water quality model first depends on the integrity of the hydrodynamic model output. The integrity of the hydrodynamic model depends upon its successful calibration and validation. While AEA provides an explanation of how it would use historical and existing water quality data to calibrate the water quality model component, the study plan does not include a detailed explanation of how AEA would calibrate the hydrodynamic model component. We note that water-surface elevations and flow velocities are common variables in hydrodynamic models; however, they are not mentioned in the RSP with respect to the EFDC hydrodynamic model component. Therefore, to successfully parameterize, verify, and validate the hydrodynamic model, water-surface elevations and flow velocities must be incorporated. Because the output of the hydrodynamic model is utilized as an input to the water quality model, the hydrodynamic model's calibration should occur prior to the calibration of the water quality model (section 5.9(b)(6)).

We recommend that AEA incorporate water-surface elevations and flow velocities when calibrating the hydrodynamic model and that the hydrodynamic model be calibrated prior to the calibration of the water quality model component of the EFDC model.

EFDC Model Initialization and Boundary Conditions as Related to Mercury Estimation

NMFS and FWS state concerns regarding the lack of data to allow reliable estimation of initial and boundary conditions[11] for the proposed reservoir component of the EFDC model. Particularly related to estimation of mercury methylation, the agencies state that since on-site data is not available to specify conditions in the reservoir after dam construction, a scientifically defensible approach to estimating those conditions is critical to obtain reliable modeling results. The agencies also state that the published model documentation for EFDC (Hamrick, 1992) does not indicate the model's capability to represent mercury methylation in the reservoir.

<u>Discussion and Staff Recommendation</u>

Development of initial and boundary conditions for the EFDC model is an important step in assessing project effects. For the proposed riverine component of the EFDC model, AEA does not discuss how it would parameterize initial or boundary conditions. The EFDC riverine model component requires dozens of parameters, some of which would be derived from basin-specific data monitored by AEA (e.g., seasonal nutrient concentrations), and some of which would necessarily be derived from a comparative literature review (e.g., light limitation threshold for different species of algae).

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[11] Initial conditions and boundary conditions are assumptions used in model development to help calibrate the model. Initial conditions define the beginning state of the watershed being modeled. Boundary conditions define inputs to the model and constrain the model to behaving within a range of accepted possibilities.

For the proposed reservoir component, AEA states that, because the dam is not in place when the model is constructed, proper calibration of the model using actual reservoir data is not possible. To achieve reasonable predictions of water quality conditions in the proposed reservoir, AEA would conduct a literature review to parameterize the reservoir model component and conduct an uncertainty analysis to account for the lack of in situ calibration data. This approach is consistent with generally accepted practices in the scientific community (section 5.9(b)(6)) where the collection of site-specific data for model calibration is not possible.

With respect to NMFS' and FWS' concern that the EFDC is not capable of representing mercury methylation in the reservoir, we note that the primary concern with respect to reservoir mercury methylation is effects on tissue concentrations of mercury in ecological receptors (i.e., fish, birds, mammals, humans). AEA's proposed approach relies on: (1) predicting water column mercury concentrations from the EFDC model; (2) two separate modeling investigations [Harris and Hutchinson Model (2008) and the Phosphorus Release Model], which focus on predicting mercury in fish tissue; and (3) a predictive risk analysis for piscivorous birds and fur bearing mammals in the vicinity of the reservoir. 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 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 potential project effects (section 5.9(b)(5)).

No modifications to the study plan are recommended.

Metrics for Evaluation of Mercury Modeling

NMFS and FWS state concerns related to the goals of the mercury modeling approach proposed by AEA and suggest that in addition to quantifying methylmercury release from the reservoir, the modeling effort should predict the impact on fish in the river downstream of the reservoir. The agencies state that estimating transport of mercury to downstream river reaches is dependent on accurately estimating internal reservoir processes, including nutrient release from decomposition of flooded terrestrial vegetation following inundation. For example, the agencies state that the RSP does not provide a description of how the modeling effort would account for nutrient release processes that would affect methylation potential in the reservoir.

Discussion and Staff Recommendation

AEA does not propose to predict mercury concentrations in biota with the EFDC model. Rather, AEA proposes to model water column concentrations of methylmercury with the EFDC model, including concentrations in the reservoir and downstream river reaches.

AEA proposes to address methylmercury production resulting from decomposition of flooded terrestrial vegetation in the proposed reservoir through implementation of the Harris and Hutchinson Model (2008) and the Phosphorus Release Model. These models are based on multiple studies of mercury methylation in reservoirs in Canada where, during the early years of the reservoirs' existence, large quantities of flooded terrestrial organic matter are subject to accelerated bacterial decomposition and increased methylation of mercury accumulated in the soil from the atmosphere. While neither model explicitly predicts rates of nutrient release or water quality concentrations of methylmercury, both offer estimations of the peak increase in fish methylmercury over background levels based on the flooding of land area possessing terrestrial organic matter. As described in detail in our analysis and recommendations for Study 5.7 (mercury assessment), use of both models would be consistent with the state of the science to evaluate potential project effects on concentrations of methylmercury within the proposed reservoir (section 5.9(b)(6)) and inform the development of any necessary license requirements (section 5.9(b)(5)).

We address the agencies request that AEA include riverine receptors in their analysis of potential methylmercury effects of the project in our analysis and recommendations for Study 5.7 (mercury assessment).

No modifications to the study plan are recommended.

Alternative Scenarios to Examine Mitigation Alternatives

NMFS and FWS state that the models proposed by AEA should include a separate and detailed description of the parameterization and initialization approach, including a description of how terrestrial conditions and dam structure and operation scenarios would be used to develop boundary conditions outside of the current riverine conditions. The agencies state that if water quality-related mitigation is warranted, the RSP needs to provide a description of how a modeling approach would be developed to examine mitigation alternatives.

Discussion and Staff Recommendation

AEA does not propose to use terrestrial conditions to develop boundary conditions for its EFDC model and it is unclear why the agencies expect that terrestrial conditions would be used to develop water quality model boundary conditions outside of the current riverine conditions. NMFS and FWS did not provide any information to support their request and we are not aware of any instances where it would be necessary to incorporate terrestrial boundary conditions into a riverine water quality model such as EFDC (section 5.9(b)(6)).

In regard to the agencies' comment that a modeling approach be developed to examine mitigation alternatives, the agencies did not describe why the EFDC model would not support an examination of mitigation alternatives. The intent of the EFDC is to simulate reservoir and riverine water quality conditions under various project operating scenarios. We therefore conclude that AEA's proposed EFDC model would provide the information necessary to evaluate project effects and support an evaluation of project alternatives, including any potential protection, mitigation, and enhancement measures (section 5.9(b)(5)).

No modifications to the study plan are recommended.

Mercury Assessment and Potential for Bioaccumulation Study (5.7)

Applicant's Proposed Study

AEA proposes to assess the potential for increased mercury concentrations in wildlife in the project area following flooding of the proposed reservoir. The study would address the following key issues:

1) Assess whether conditions in the project area would cause mercury methylation if the reservoir is flooded.

2) Evaluate the concentrations of methylmercury that might occur.

3) Assess whether a mechanism exists (e.g., fish and small invertebrates living in the methylation zone) to transfer methylmercury to wildlife at levels of concern.

Based on the key issues, AEA proposes to include the following specific study objectives.

- Summarize available and historic water quality information for the Susitna River Basin, including data collection from the 1980s Alaska Power Authority (APA) Susitna Hydroelectric Project.

- Characterize the baseline mercury concentrations of vegetation, soil, water, (riverine) sediment and sediment pore water, piscivorous birds and mammals, and fish in the Susitna River and tributaries.

- Use available geologic information to determine if a mineralogical source of mercury exists within the inundation area.

- Map mercury concentrations of soils and vegetation within the proposed inundation area. This information would be used to develop maps of where mercury methylation may occur.

- Use the water quality model to predict where and when reservoir conditions (i.e., pH, DO, turnover periods) are likely to be conducive to methylmercury formation.

- Use modeling to estimate methylmercury concentrations in fish.

- Assess potential pathways for methylmercury to migrate to the surrounding environment.

- Coordinate the evaluation of study results with other studies, including fish, instream flow, and other piscivorous bird and mammal studies.

The study area for this study is consistent with that of Study 5.5 (baseline water quality), and includes the mainstem Susitna River from RM 15.1 to 233.4, as well as tributaries that contribute large portions of the Lower River flow (i.e., Talkeetna, Chulitna, Deshka, and Yentna Rivers), and smaller tributaries that represent important spawning and rearing habitat for anadromous and resident fisheries (i.e., Gold, Portage, Tsusena, and Watana Creeks, and the Oshetna River).

AEA's proposed study methods are summarized below.

AEA proposes to summarize available information for the Susitna River Basin, including data collection from the 1980s APA Susitna Project, and existing geologic information, to determine if a mineralogical source of mercury exists that could provide inputs to the reservoir.

Background vegetation would be collected and analyzed for total mercury concentrations, with up to 50 samples of leaves and needles from plants exhibiting relatively high total vegetative mass within the proposed inundation area. Vegetation percent cover would also be recorded to provide additional vegetation mapping data. The vegetation survey would occur one time during the summer of 2013.

Soil samples would be collected and analyzed for thickness, extent, and total mercury concentrations of the upper organic soil horizon (i.e., upper 5 to 7 inches of material) coincident with the vegetation samples. The soil survey would occur one time during the summer of 2013.

Surface water samples would be collected and analyzed for total and methylmercury concentrations at 17 sites monitored monthly from June to September, once in December, and once in March for one year in 2013. Consistent with Study 5.5 (baseline water quality), the monitoring period covers the beginning of ice break-up in June through ice formation in September, as well as two winter sampling events in December and March.

Riverine sediment would be collected and analyzed for total mercury, total organic carbon, and grain size, and sediment pore water for total and methylmercury at 10 sites. Monitoring sites would be located upstream and downstream of the proposed dam site and near the mouths of eight tributaries near the dam site (i.e., Fog, Deadman, Watana, Tsusena, Kosina, Jay, and Goose Creeks and the Oshetna River). Sediment samples would be collected from areas of slow current (i.e., backwaters, downstream of islands, side channels, etc.). The sediment and pore water survey would occur one time during the summer of 2013.

Feathers of piscivorous birds, including raptors (principally bald eagles), loons, grebes, arctic terns, and kingfishers, would be collected and analyzed for total mercury. Feathers would be collected from raptor and waterbird nests, after the nests have been vacated for the season, and from kingfisher burrows. Collections would occur during wildlife surveys in 2013 and 2014.

Fur samples of aquatic furbearers (mammals), including river otters and mink, would be collected and analyzed for total mercury. Collections would be made from animals presented to the Alaska DFG for identification after being trapped, or, if that approach generates low sample numbers, from hair-snag traps placed at or near the mouths of eight tributaries near the proposed dam site (i.e., Fog, Deadman, Watana, Tsusena, Kosina, Jay, and Goose Creeks and the Oshetna River). The aquatic furbearer survey would occur one time during the summer of 2013.

AEA also proposes to perform a risk analysis for the potential impacts of the project on piscivorous birds and aquatic furbearers that involves comparing predicted mercury exposures under project conditions against literature-established toxicity reference values (TRV) for each species.

Fish tissue samples from Dolly Varden, artic grayling, stickleback, longnose sucker, whitefish species, lake trout, burbot, and resident rainbow trout, would be collected and analyzed for total and methylmercury in up to seven adult individuals from each species. Tissue samples would be fillets (muscle samples); liver samples would also be collected from burbot. If possible, fish age would be determined using otoliths and scales. If larger fish of a given species are not captured, smaller fish would be targeted, and a relationship between mercury concentration and fish size would be developed. The fish survey would occur one time during the summer of 2013.

EPA Method 1669 (Clean Hands/Dirty Hands) would be used for all mercury-related sampling. Analysis of total mercury would be conducted using EPA Method 1631, and analysis of methylmercury would be conducted using EPA Method 1630.

Results of the sediment, water, and tissue analyses would be compared to Alaska state criteria, or where those are not available, threshold screening values from NOAA Screening Quick Reference Tables (SQuiRTs).

As described in Study 5.6 (water quality modeling), AEA proposes to develop a water quality model using the EFDC to predict where and when reservoir conditions (i.e., pH, DO, turnover periods, etc.) are likely to be conducive to methylmercury formation. AEA would also use specialty models to predict potential fish methylmercury concentrations under the proposed project condition. The Harris and Hutchinson (2008) model would be used to provide an initial prediction of peak mercury concentrations in fish in the proposed reservoir. The Phosphorus Release Model would be used if there is a need to evaluate when peak methylmercury production would occur in the proposed reservoir.

AEA would conduct a pathway assessment to evaluate the potential pathways for methylmercury to move into the ecosystem, both from the reservoir and downstream of the reservoir. The assessment would use available literature and would incorporate existing conditions (i.e., no dam) and proposed project conditions with the reservoir and dam in place.

Comments on the Study

Legacy Mining as a Potential Source of Mercury

Based on background concentrations of total mercury measured in surface waters of the project watershed, NMFS and FWS comment that AEA should contact a subject matter expert such as John Gray with the USGS regarding the presence or absence of mercury mining impacts in the project watershed to inform potential mitigation efforts.

Discussion and Staff Recommendation

AEA cites mercury background information from the specified expert in RSP section 5.7.2 (Bailey and Gray, 1997; Gray et al., 2000), although the citations refer to the Kuskokwim area of Alaska rather than the project area. AEA also states that it would review existing geologic information to determine if a mineralogical source of mercury exists within the inundation area. There is nothing to suggest that the geologic information would not be shared and vetted among experts and study team members as stated in the study plans. We consider this to be part of the standard QA/QC process that would be employed by the study team.

No modifications to the study plan are recommended.

Definition of What Constitutes Background

NMFS and FWS request that AEA define the term “background” with respect to concentrations of mercury in various environmental matrices in the project area. The agencies state that an agreed upon definition is needed to determine the potential effects of the proposed reservoir on mercury concentrations in the project area.

Discussion and Staff Recommendation

AEA uses the term "background" in multiple instances throughout the study plan. It appears that AEA uses “background” to indicate that mercury levels are either 1) naturally occurring, or 2) occurring as an existing condition prior to the proposed reservoir, even if the existing mercury is from an anthropogenically enhanced source (i.e., atmospheric deposition).

We agree that it is important to be clear about what is meant by “background”. However, if the results of the proposed studies indicate that the project would result in an increase in mercury levels above existing-conditions, then regardless of the terminology, there would be a demonstrated project effect, which would be useful in the development of potential environmental measures and license conditions (section 5.9(b)(5)).

No modifications to the study plan are recommended.

Long-term Monitoring

NMFS and FWS comment that a one-time baseline survey is not sufficient for characterizing potential long-term project effects on mercury methylation in the proposed reservoir and downstream reaches of the Susitna River. The agencies state that a long-term dataset is needed to validate the proposed mercury models, to allow ecological risk assessments for piscivorous birds and fur bearing mammals, and to inform adaptive management actions.

Discussion and Staff Recommendation

AEA proposes to assess the long-term effects of the proposed project on mercury methylation potential by model predictions of water column mercury concentrations from EFDC, two separate investigations focused on predicting mercury fish tissue levels, and a predictive risk analysis for piscivorous birds and fur bearing mammals in the vicinity of the reservoir. 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 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)(5)), and develop any future license conditions to address mercury methylation.

No modifications to the study plan are recommended.

Wetlands and Pre-impoundment Mitigation Strategies

NMFS and FWS state that methylmercury toxicity may be reduced by a number of possible pre-construction management strategies and these strategies need to be critically evaluated before project construction. The agencies state that an understanding of wetland types, acreage, and locations within the inundation zone would be critical in the design and implementation of pre-impoundment mitigation strategies and that vegetation removal, which is mentioned in the RSP, may be prohibitively expensive.

Discussion and Staff Recommendation

AEA states that it would review potential strategies to manage mercury methylation, bioaccumulation, and biomagnification, citing Mailman et al. (2006) (RSP section 5.7.4.10). Mailman et al. (2006) considered the following strategies: selecting sites to minimize impacts (i.e., avoiding wetlands where possible), intensive fishing, adding selenium, adding lime to acidic systems, burning vegetation before flooding, removing standing trees, adding phosphorus, demethylating methylmercury by ultraviolet light, capping and dredging bottom sediment, aerating anoxic bottom sediment and waters, and water level management.

Because mercury impacts are expected under the proposed project, consideration of potential strategies to minimize anticipated impacts would be necessary to inform the development of license requirements (section 5.9(b)(5)), including any potential strategies to be implemented prior to construction. Strategies related to avoiding the flooding of wetlands would require background data collection to assess wetland occurrence and extent within the reservoir footprint in order to assess the potential for mercury methylation upon flooding. Strategies related to soil and vegetation management would require background data collection to ascertain their potential applicability for the proposed project. AEA already proposes to quantify total mercury in terrestrial vegetation and organic soils in the inundation area through a survey in the summer of 2013 (RSP sections 5.7.4.2.1 and 5.7.4.2.2). This information would include mapping of vegetation types, which would inherently include wetland vegetation, and would provide useful background information to be used in the consideration of pre-construction methylmercury management strategies such as reservoir siting to avoid wetlands (where possible), vegetation removal, or soil treatment (section 5.9(b)(5)).

No modifications to the study plan are recommended.

Predictive Risk Analysis

NMFS and FWS state that the proposed predictive risk analyses for mercury should consider direct risks to aquatic organisms, including organisms that eat fish, such as terrestrial and aquatic piscivorous birds and mammals, and organisms that are eaten by fish, such as zooplankton. The agencies state that the behavior of receptors (species likely to ingest and accumulate mercury), such as feeding rates, could change as a result of the project, which could be an important consideration in the overall analysis. The agencies request a complete description of receptors of concern, water and food consumption rates for each receptor, and TRVs needed to conduct the predictive risk analysis. FWS requests that AEA coordinate with them regarding this information prior to conducting the predictive risk analysis for review and concurrence.

Discussion and Staff Recommendation

The primary concern with respect to reservoir mercury methylation is tissue concentrations in ecological receptors (i.e., fish, birds, mammals, humans). AEA's proposed predictive risk analysis includes piscivorous birds (i.e., kingfisher, loon, osprey, bald eagle) and fur-bearing mammals (i.e., river otter, mink), and includes an assessment of food consumption rates and TRVs for each species. The potential for changes in receptor feeding rates as a result of the project is not discussed in the RSP. AEA states that it would not quantify mercury concentrations in zooplankton because of the inherent variability across species, season, and location found in other studies (Henderson et al. 2011, Rennie et al. 2011), and thus predictions of zooplankton mercury content would have limited applicability.

Overall, 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 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)(5)). Nevertheless, further refinement of assumptions for the predictive risk analysis in coordination with FWS, as would occur during study implementation and in response to the initial study report, would decrease uncertainty in the predicted results.

No modifications to the study plan are recommended.

Use of Harris and Hutchinson and EFDC Models for Mercury Estimation

NMFS and FWS comment that the Harris and Hutchinson (2008) model is a screening level assessment, does not lead to a firm prediction, and must be combined with other tools and observations from existing reservoirs to estimate the likely outcome. The agencies also comment that there are no peer-reviewed articles on the successful use of either the EFDC or the Phosphorous Release Model for predicting mercury in biota or successfully estimating mercury methylation rates in waters. The agencies state that no models can predict methylation rates with any confidence.

Discussion and Staff Recommendation

The Harris and Hutchison (2008) model is a simple linear model, having a small number of model parameters: total flooded area, total reservoir area, mean annual flow, and concentrations of mercury in fish tissue under existing conditions. It provides a first-order approximation of the peak increase in fish methylmercury over background levels once a reservoir is flooded. However, at least one other study has found that the model is not precise and lacks the predictive capability of more dynamic models that are based on a state-of-the-science understanding of mercury cycling in the environment (Azimuth, 2010). Despite this, the model is easy to use and does not require extensive parameterization and prior data collection.

AEA also proposes to use the semi-empirical Phosphorus Release Model to predict mercury concentrations in reservoir fish that accounts for reservoir filling time and the percentage of flooded land area in the drawdown zone, two important factors in determining methylmercury concentrations in reservoir fish tissue. However, AEA would only use this model if the other two models (i.e., EFDC, Harris and Hutchinson) predict that methylation potential is significant. We note that AEA does not define what would be considered significant.

AEA states in section 5.7 of the RSP that the EFDC model would predict conditions conducive to methylmercury production in the water column (i.e., low DO, low pH, reservoir stratification); in section 5.6.4.8 of the RSP, AEA states that the EFDC model would predict mercury concentrations in the water and would account for potential sources of mercury as the reservoir is filled (e.g., soils, vegetation, air deposition). While AEA states that algorithms representing mercury as a sorptive[12] toxic variable in the toxic model component have been successfully used in other studies, the study plan lacks a detailed discussion of how the EFDC model would predict mercury concentrations in the proposed reservoir.

As noted above, the combined use of a modified mechanistic water quality model (EFDC), an empirically-based fish tissue model from other hydroelectric impoundment studies in North America, and the predictive risk analysis based on established TRVs 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)(5)). However, because we anticipate greater uncertainty in results from the Harris and Hutchinson (2008) screening level model, the potential for mercury methylation already appears to be high, and the Phosphorus Release Model is less simplistic than the proposed Harris and Hutchinson (2008) model, we see little information to suggest that it would be appropriate to implement the Phosphorus Release Model only if the initial screening level model and EFDC suggest that methylation potential would be significant. We estimate that the anticipated level of effort to run the Phosphorus Release Model would be two to three weeks or approximately $15,000 to $20,000 (section 5.9(b)(7)).

For these reasons, we recommend that AEA use the more sophisticated Phosphorus Release Model to predict peak methylmercury levels in fish tissue, regardless of the outcome of the other two models.

[12] Sorption is the chemical process of transitioning from a dissolved compound to a compound associated with sediment particles.

Mercury Effects on Riverine Receptors

NMFS and FWS stated concerns related to the goals of the mercury modeling approach proposed by AEA and suggested that the modeling effort should predict the impact on fish in the river downstream of the reservoir.

Discussion and Staff Recommendation

AEA proposes to address 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 for piscivorous birds and aquatic fur-bearing mammals (RSP section 5.7.4.9). However, the predictive risk analyses do not identify riverine receptors (i.e., biota living downstream of the reservoir that may be exposed to elevated methylmercury concentrations produced in the reservoir and discharged to the river) or provide relevant TRVs as metrics for riverine receptors.

We recommend that AEA include likely riverine receptors (i.e., biota living downstream of the reservoir that may be exposed to elevated methyl mercury concentrations produced in the reservoir and discharged to the river) as part of the predictive risk analysis. The additional study element would have a low cost (section 5.9(b)(7)) because AEA would simply add consideration of additional receptors to the existing analysis. This information is necessary to evaluate potential project effects downstream of the reservoir (section 5.9 (b)(5)).

Geomorphology (6.5)

Applicant's Proposed Study

AEA proposes a study to characterize the geomorphology and sediment dynamics of the Susitna River channel and predict the trend and magnitude of geomorphic response to the proposed project. The results of this study would be used together with the results of Study 6.6 (geomorphology modeling) to predict changes in channel morphology and sediment dynamics from project operations.

For the purposes of this study, the river is divided into three study segments:

1) Upper River segment: Maclaren River confluence (RM 260) downstream to the proposed dam site (RM 184),

2) Middle River segment: proposed dam site (RM 184) downstream to the three rivers confluence area (RM 98.5), and

3) Lower River segment: three rivers confluence area (RM 98.5) downstream to Cook Inlet (RM 0).

The study would include a variety of methods to achieve specific study objectives. The specific objectives and associated methods are summarized below.

1) Geomorphically characterize project-affected river channels and floodplains by delineating reaches and mapping geologic and geomorphic features from the proposed dam site downstream to Cook Inlet and from the dam site upstream to the Maclaren River confluence (including the reservoir inundation zone).

2) Collect flow, suspended sediment, and bedload data to support characterization of sediment supply and transport in the Susitna River from RM 84 (Sunshine Station) upstream to RM 182 (Tsusena Gage) and the Chulitna and Talkeetna Rivers near their confluences with the Susitna River.

3) Determine sediment supply, bed mobilization, sediment transport, and mass balance in the Middle River and Lower River segments between the proposed dam site and downstream to the Susitna Station gage, including the mainstem Susitna River and its tributaries.

4) Assess geomorphic stability and change in the Middle River and Lower River segments by comparing existing geomorphic mapping with geomorphic feature data from historical aerial photography.

5) Characterize surface area versus flow relationships for riverine macrohabitat types over a range of flows in the Middle River segment from the three rivers confluence area upstream to the dam site using information mapped and digitized from aerial photography.

6) Conduct a reconnaissance-level geomorphic assessment of potential project effects on the Lower River segment and Middle River segment, considering stream flow, sediment supply and transport, and conceptual frameworks for geomorphic reach response (Grant et al., 2003; Germanoski, 1989).

7) Characterize surface area versus flow relationships for riverine macrohabitat types in the Lower River segment between the Yentna River confluence (RM 28.5) and Talkeetna (RM 98.5); the task includes conducting analyses contingent on a determination that (1) a comparison of

riverine habitat in the Lower River segment under pre- and post-project flows is warranted for additional flow conditions and (2) aquatic resource studies need to be continued downstream in the Lower River segment.

8) Characterize geomorphology within the proposed reservoir area and assess reservoir trap efficiency, sediment accumulation rates, delta formation, and erosion and mass wasting potential within the reservoir fluctuation zone and shoreline up to 100 vertical feet above the proposed full-pool elevation.

9) Assess large woody debris transport, recruitment, and influence on geomorphic forms in the Susitna River between the mouth and the Maclaren River using recent and historic aerial photography and field studies.

10) Characterize geomorphic conditions (i.e., channel morphology and sediment dynamics, channel migration zone, large woody debris transport, and erosion and sediment delivery) at stream crossings along access roads and transmission line alignments using data obtained from existing sources and field assessment.

11) Integrate the study with Study 6.6 (fluvial geomorphology modeling).

Comments on the Study

Field Data Collection

FWS states that the density and resolution of survey data (e.g., aerial photography, transects, and LiDAR[13]) are not described in detail, and requests that AEA provide a more detailed explanation of how cross-section and bathymetric survey locations were selected.

Discussion and Staff Recommendation

The RSP and associated supplementary filings describe the density and resolution of survey data consistent with generally accepted scientific practice (section 5.9(b)(6)).

[13] Light Detection and Ranging (LiDAR) is a remote sensing method that uses light in the form of a pulsed laser to measure variable distances to the ground to generate precise, 3-dimensional information about the ground surface.

Appendix 1 of the Open Water HEC-RAS Flow Routing Model[14] report describes the methods used to select and survey 88 cross sections in 2012 between RM 75 and RM 184. The RSP indicates that additional cross-sections would be collected in 2013, a portion of which would be derived from transects and bathymetric data collected in Middle River focus areas. Section 6.6.4.1.2.9.2 of the RSP describes methods for collecting bathymetric, cross-sectional, and topographic information in focus areas. The technical memorandum filed on March 1, 2013, titled *Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014* (herein referred to as the Final Focus Area Tech Memo) provides additional information regarding selection of cross sections to be surveyed on the lower portion of five tributaries in the Lower River segment. We find that the RSP and associated supplementary filings adequately describe the density and resolution of survey data and the selection of cross section and bathymetric survey locations.

No modifications to the study plan are recommended.

Site Selection and Stability Assessment

NMFS and FWS state that AEA selected study sites that were relatively stable during the period from the 1980s to present, and recommend that AEA investigate more dynamic sites in addition to the five proposed sites. NMFS and FWS also recommend that AEA study the current and with-project stability of dynamic tributaries, including the confluence of the Susitna, Chulitna, and Talkeetna Rivers (three rivers confluence).

NMFS, FWS and Talkeetna Community Council, Inc. (TCCI) recommend that AEA evaluate the interaction of geomorphic processes in the three rivers confluence area.

<u>Discussion and Staff Recommendation</u>

As described in RSP section 6.5.4.7, AEA selected relatively stable sites for the riverine habitat area versus flow assessment in the Lower River segment. This is an appropriate criterion for site selection where the objective is to assess the potential for project-related stage changes that could alter riverine habitat. Incorporating more dynamic sites would make determination of stage-dependent habitat changes difficult to distinguish from habitat changes related to non-project-related channel adjustments (i.e., erosion or deposition). For these reasons, we conclude that AEA's proposed approach is consistent with generally accepted practices (section 5.9(b)(6)), and an investigation of

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[14] Prepared for Alaska Energy Authority by R2 Resource Consultants, Inc.; GW Scientific; Brailey Hydrologic; and Geovera; January 2013.

more dynamic sites in addition to the proposed sites, as requested by NMFS and FWS, is not necessary to evaluate project effects (section 5.9(b)(5)).

With respect to tributaries, AEA proposes measurements and analyses to address potential project effects on geomorphology, fish passage, and fish habitats at five tributary mouths in the Lower River segment: Trapper Creek, Birch Creek, Sheep Creek, Caswell Creek, and Deshka River. These sites are a subset of tributary mouths identified in the 1980s as important habitat with the potential to be affected by a hydroelectric project proposed at that time (Ashton and Trihey, 1985). AEA proposes to investigate potential changes in sedimentation and hydraulics at these five tributary mouths in the Lower River segment using methods described in section 4.2.5 of the Final Focus Area Technical Memo. AEA also proposes to study focus areas in the Middle River segment that encompass three tributary mouths (i.e., Portage Creek, Indian River, and Whiskers Creek). AEA's proposed tributary study sites and methods of analyzing geomorphic changes at these sites satisfy NMFS' and FWS' recommendations to study the stability of dynamic tributaries.

We address the commenters request that AEA evaluate geomorphic processes in the three rivers confluence area in our analysis and recommendations for *Interaction of Geomorphic Processes in the Mainstem and Tributaries* in Study 6.6 (geomorphology modeling).

No modifications to the study plan are recommended.

Geomorphologic Effects at Stream Crossings

NMFS and FWS request that AEA evaluate soil and streambed compaction at potential stream crossings. The agencies also request that stream crossings meet NMFS' crossing criteria for anadromous water bodies (NMFS, 2011). NMFS and FWS state that compaction of the soil and streambed in the vicinity of planned stream crossings could alter stream ecology.

Discussion and Staff Recommendation

The RSP states that AEA would evaluate the potential effects of stream crossings on stream geomorphology, and the results would be used to design stream crossings, and develop protection, mitigation and enhancement (PM&E) measures to minimize the effects of the crossings. As part of the design process, AEA would need to collect geotechnical information to design the foundation of each stream crossing and to develop soil erosion and sediment control measures. We find that the request by NMFS and FWS to have stream crossings meet NMFS' crossing criteria for anadromous waterbodies would be a PM&E measure rather than a study-related request. NMFS and FWS would have multiple opportunities to comment and recommend PM&E measures after the studies are completed, and any such recommendations would be addressed in the EIS.

No modifications to the study plan are recommended.

Stream Flow and River Stage Assessments

NMFS, FWS, and TCCI state that AEA did not provide the results of a flood frequency analysis for the Susitna River gages and tributary gages in January 2013, as proposed in the RSP. These results would be used to assess the potential for project operations to alter erosion patterns in the area near the confluence with the Talkeetna and Chulitna Rivers. AEA states in the RSP that "If this initial analysis indicates that the changes in flows and stage on the Susitna River may be sufficient to alter the flow patterns during peak flows on the Talkeetna and Chulitna Rivers, then a plan would be developed to further study this potential project effect in 2014." NMFS and FWS point out that the threshold requiring further geomorphic investigation was not provided, and recommend that a 10-percent change in mean cross-sectional depth and/or a 10-percent change in the cross-sectional wetted area be used as a minimum threshold for further assessment of geomorphic changes as a result of project operations.

NMFS and FWS state that AEA proposes to compare pre- and post-project stream flow using stage-discharge relationships for the Sunshine and Susitna Station gaging locations. NMFS and FWS point out that the RSP indicates additional parameters may be analyzed in 2013 to describe and compare pre- and post-project water surface elevations. However, the agencies state it is unclear what would determine if the additional parameters are analyzed or what the additional parameters would be. NMFS and FWS recommend that AEA compare changes in wetted cross-sectional area and percent of wetted cross-sectional area change between pre- and post-project operations. The agencies add that this analysis should be conducted for monthly, daily, and hourly time scales to capture the changes in flow proposed as part of the winter load-following operations.

Discussion and Staff Recommendation

AEA prepared the Stream Flow Assessment[15] report that describes the potential effects of post-project streamflow on flood frequency, stage-discharge relationships, and cross-sectional flow characteristics at Susitna River gages and tributary gages, which

[15] Prepared for Alaska Energy Authority by Tetra Tech, Inc; February 2013.

NMFS, FWS and TCCI request in their study comments. The Stream Flow Assessment indicated an appreciable post-project reduction in the 1.5- to 5-year flow rates in the Lower River segment. The reduction in these flow rates could result in narrowing of the channel width by more than 10 percent in the portion of the Lower River segment downstream of Sunshine, and less than 10 percent downstream from the Yentna River confluence. These preliminary results served as part of the decision criteria to extend the study area for Study 6.6 (geomorphology modeling) 50 miles further downstream in the Lower River segment to the USGS Susitna Station Gage. The recommendation from MNFS and FWS that AEA analyze additional pre- and post-project stage-discharge parameters in 2013 is no longer relevant or necessary, given that AEA has adjusted the downstream extent of their proposed geomorphic investigations 50 miles further downstream in the Lower River segment to provide more detailed assessment of potential project effects. Therefore, we find that AEA has adequately identified the potential for adverse project effects on geomorphology and cross-sectional flow characteristics in the Lower River segment, and has adjusted the downstream extent of their proposed geomorphic investigations to provide a more detailed assessment of these potential effects. This is a reasonable approach that should provide the information necessary to evaluate project effects (section 5.9(b)(5)).

No modifications to the study plan are recommended.

Testing Hypotheses Regarding Potential Impacts on Channel Morphology Downstream of the Chulitna and Talkeetna Rivers Confluence

NMFS and FWS recommend that AEA state how the results of the reconnaissance-level assessment of project effects on the Middle River and Lower River Segments (RSP section 6.5.4.6) would be used to test hypotheses about the potential project effects on channel morphology downstream of RM 84, as well as describing alternative hypotheses that would be considered. NMFS and FWS state that AEA appears biased in forecasting geomorphic alterations in the Susitna River downstream of the Chulitna and Talkeetna River confluences.

Discussion and Staff Recommendation

The RSP states that the large contributions of tributary flow and sediment supply from the Chulitna and Talkeetna Rivers relative to the Susitna River, combined with channel and valley floor morphology in the confluence area, would likely mitigate potential project-related impacts to river geomorphology below the confluence area. This initial hypothesis of the potential geomorphic effects of the project on river geomorphology below RM 84 is adequately tested by analyses presented in section 6.5.4.6 of the RSP and associated supplementary filings. AEA concluded that the potential for significant change in the Lower River segment downstream from Sunshine is indeterminate, and that it cannot be concluded with certainty that the impacts of the project would be acceptably small. Therefore, AEA has stated that as a result of these preliminary results, they would investigate the potential project-related effects downstream to the Susitna Station gage, including bed material and bed-load sampling and 1-dimensional sediment-transport modeling to quantify the magnitude of the potential project-related impacts. This is a reasonable approach that should provide the information necessary to evaluate project effects (section 5.9(b)(5)).

No modifications to the study plan are recommended.

Effective Discharge

TCCI requests details regarding how AEA plans to determine and model effective discharge in the Susitna River drainage. CSDA also states that the discussion of effective discharge in the RSP is lacking, and requests that AEA consider an ecoregional approach to assessing effective discharge values (e.g., Simon et al., 2004).

<u>Discussion and Staff Recommendation</u>

As described in section 6.5.4.3.2.4 of the RSP, AEA proposes to compute effective discharge for the Susitna River downstream of Tsusena Creek, at Gold Creek, and at Sunshine. These methods are consistent with generally accepted scientific practices and should be sufficient to characterize effective discharge at the proposed locations (section 5.9(b)(6)).

No modifications to the study plan are recommended.

Random Meteorological Events

TCCI states that neither this study nor Study 6.6 (geomorphology modeling) address random meteorological events.

<u>Discussion and Staff Recommendation</u>

Section 6.6.4.2.2.3 of the RSP describes AEA’s approach to identifying, understanding, and assessing the uncertainties including hydrologic variability. These methods are consistent with generally accepted scientific practices and should be sufficient to identify, understand, and assess the uncertainties including hydrologic variability.

No modifications to the study plan are recommended.

Fluvial Geomorphology Modeling Below Watana Dam Study (6.6)

Applicant's Proposed Study

AEA proposes to conduct a study to predict evolution of bed morphology and gradation in the Susitna River downstream of the proposed dam under existing conditions and future conditions with the proposed project using one- and two-dimensional sediment transport models.

For the purpose of this study, the study area includes two river segments:

1) Middle River from the dam site at RM 184 downstream to the three rivers confluence area at RM 98.5, and

2) Lower River from the three rivers confluence downstream to RM 75.

A one-dimensional bed evolution model would be used to predict geomorphic response of the Susitna River in the entire study area (excluding Devils Canyon) at the reach scale, and a two-dimensional bed evolution model would be used to evaluate detailed hydraulic and sediment transport characteristics at local scales in focus areas and at primary tributary deltas. Information from this study, in combination with results from other studies, would be used to predict the potential effects of the proposed project on fluvial geomorphology and associated instream and riparian habitat.

The study would include a variety of methods to achieve specific study objectives. The specific objectives and associated methods are summarized below.

1) Develop the bed evolution model and modeling approach; coordinate with other studies on processes to be modeled; and calibrate/validate the models using measured water surface elevations, flow depths, and velocities; measured sediment transport data and associated sediment rating curves for bedload and suspended load; and measured changes in bed elevations and bed material gradations.

2) Apply the developed models to estimate the potential for channel change under existing conditions and future conditions under three different operating scenarios including, maximum load-following, intermediate load-following, and base-load.

3) Coordinate modeling with Study 6.5 (geomorphology) to integrate and interpret the results with respect to the key processes identified and key issues to address.

4) Support the evaluation of project effects by providing channel output data and assessment of potential changes in geomorphic features that comprise aquatic and riparian habitats.

Comments on the Study

Modeling in Focus Areas

NMFS and FWS request additional detail on the proposed modeling approaches to enable them to assess the validity of the modeling approaches, data requirements, and calibration process. NMFS and FWS also state that it is unclear how predicted changes in channel form due to modified streamflow and ice regimes would be integrated into an impact assessment. NMFS and FWS recommend that AEA use the one- and two-dimensional hydraulic and bed evolution models to estimate changes in geomorphology and habitat area at each of the Middle River focus areas and Lower River stability sites (including the Susitna River confluence with both the Chulitna and Talkeetna Rivers).

Discussion and Staff Recommendation

Section 6.6.4 of the RSP describes development, coordination, and calibration of AEA's bed evolution modeling approach. AEA proposes an approach that uses the one-dimensional HEC-6T model to address reach-scale project effects and a two-dimensional model to address local-scale project effects. In the final Focus Area Tech Memo, AEA states that HEC-RAS would be used at the downstream end of the tributaries in the Lower River. The RSP states that the two-dimensional model would be applied in the Middle River and Lower River segments and to specific focus areas selected in coordination with licensing participants. The RSP also states that two-dimensional modeling would be applied at most if not all of the focus areas, including selected primary tributary areas. AEA indicates that the two-dimensional model would be selected from a preliminary list of candidate models in coordination with the other studies and the licensing participants. AEA's schedule for implementing the study indicates that the process for selecting one- and two-dimensional models would be described in a technical memorandum prepared in the second quarter of 2013. AEA provides no additional specific details about the information that would be included in the technical memorandum.

The RSP provides sufficient detail describing the candidate models, their data requirements, calibration and validation processes, and the relative strengths and weaknesses in their application to the Susitna River system. However, the RSP does not provide the necessary detail describing information to be included in the technical memorandum, including where the one- and two-dimensional models would be applied.

The RSP also does not provide an understanding of how ice and large wood debris (LWD) would be incorporated into the one- and two-dimensional models.

We recommend that AEA file by June 30, 2013, the proposed technical memorandum related to the selection and application of the one- and two-dimensional models (proposed for development in the second quarter of 2013). We also recommend that the technical memorandum include the following information:

1) specification of the one- and two-dimensional models to be used in the fluvial geomorphology modeling pursuant to this study as well as the aquatic habitat models pursuant to Study 8.5 (fish and aquatics instream flow);

2) location and extent of one- and two-dimensional geomorphology and aquatic habitat modeling in project reaches, focus areas, and other study sites;

3) rationale and criteria for model selection including an overview of model development;

4) for fluvial geomorphology modeling only, a detailed description of the processes and methods by which ice and LWD would be incorporated into the modeling approach (as described in our recommendations for Incorporating Large Woody Debris and Ice Processes into Fluvial Geomorphic Modeling); and

5) documentation of consultation with the TWG, including how the TWG's comments were addressed.

We expect additional detail on model parameterization, model calibration, model validation, and sensitivity analysis would be included in the initial and updated study reports.

Interaction of Geomorphic Processes in the Mainstem and Tributaries

NMFS, FWS, TNC, and CSDA express concern that changes in fluvial geomorphology resulting from the project could propagate upstream into tributaries where channel gradient and sediment transport dynamics are not controlled by bedrock, and that these changes could affect habitat in tributaries and off-channel areas. NMFS, FWS, and CSDA question the assumption that tributary channel gradients and sediment inputs would not change as a result of the project. EPA provides similar comments questioning AEA's treatment of tributary sediment input as constant in fluvial geomorphic modeling and states that no studies are currently planned to evaluate potential interactions between mainstem and tributary geomorphic responses. NMFS, FWS, and CSDA recommend that modeling be expanded to assess: (1) the likelihood that changes to mainstem channel hydrogeomorphology caused by the project would propagate up tributaries; (2) the likelihood that such changes would in turn affect mainstem and delta geomorphology; and (3) the likelihood that such propagating changes along at least some of the tributaries would affect the abundance and quality of aquatic and riparian habitat along the affected tributaries. NMFS and FWS recommend that AEA analyze any tributary mouth or slough that would likely experience incision[16] as a result of the project.

NMFS and FWS request that AEA investigate the confluence of the Susitna and Chulitna Rivers and Susitna and Talkeetna Rivers using approaches similar to those proposed in Middle River focus areas. TCCI requests that AEA expand this study and Study 6.5 (geomorphology) to encompass all three branches of the confluence and specifically address how project-related channel change would affect the town site and residential properties in Chase. NMFS, FWS, and TCCI express particular concerns that geomorphic changes resulting from the project may occur at the confluence of the Susitna and Chulitna Rivers, and the Susitna and Talkeetna Rivers.

Discussion and Staff Recommendation

AEA proposes measurements and analyses to address potential project effects on geomorphology (e.g., erosion, sedimentation, and hydraulics) at five tributary mouths in the Lower River segment (Trapper Creek, Birch Creek, Sheep Creek, Caswell Creek, and Deshka River) using methods described in section 4.2.5 of the Final Focus Area Tech Memo. AEA also proposes to study focus areas in the Middle River segment that encompass three tributary mouths (i.e., Portage Creek, Indian River, and Whiskers Creek). AEA's proposed tributary study sites and focus areas and the methods of analyzing geomorphic changes at these sites would satisfy the recommendations by NMFS, FWS, TNC, CSDA, and EPA.

In the RSP, AEA states that geomorphic analyses (i.e., modeling) at tributary confluences with the Susitna River may include the three rivers confluence area, but that bed evolution modeling in this area may not be feasible. AEA does not identify an alternative framework or process for studying the potential effects of the proposed project on the stability of the Chulitna and Talkeetna Rivers in the vicinity of the three rivers confluence. We note that this location is both an environmentally sensitive area of high

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[16] Incision is the deepening of the channel through erosion of the stream bed.

fish use as well as the location of a fairly large population center in Talkeetna. For these reasons, we conclude that the information would be needed to evaluate project effects (section 5.9(b)(5)). Including additional information on how geomorphic change would be evaluated at the confluence of the Chulitna, Talkeetna, and Susitna Rivers would improve the study at minimal cost or effort (section 5.9(b)(7)).

We recommend the study plan be modified to include a defined approach to evaluating geomorphic changes at the confluence of the Chulitna, Talkeetna and Susitna Rivers. The evaluation should extend from the mouth of both the Chulitna and Talkeetna Rivers to the potentially affected upstream reaches of these tributaries. We recommend that AEA prepare a technical memorandum detailing a proposed approach for evaluating geomorphic changes in the three rivers confluence area, including explicitly stated objectives for evaluating geomorphic changes, an overview of the technical approach, additional data collection required, models and model components to be used, and additional analyses that would be conducted to address the stated objectives. We recommend that AEA file by June 30, 2013, this technical memorandum to include documentation and consultation with the TWG, including how the TWG's comments were addressed.

Incorporating Large Woody Debris and Ice Processes into Fluvial Geomorphic Modeling

NMFS, FWS, CSDA, and TNC state that the proposed project has a high potential to alter ice dynamics along the Upper River and Middle River segments, and that the RSP does not explicitly state whether or how the two-dimensional modeling tools under consideration would incorporate the effects of ice dynamics on channel planform. The commenters state that AEA indicates that investigators would use data from focus areas to integrate information on the possible roles of ice dynamics in shaping channel geomorphology, but that the RSP does not indicate how this would be done. NMFS and FWS recommend that AEA prepare a framework that would be used to better understand the interaction of ice dynamics and geomorphology in focus areas, including clarification regarding the technical feasibility of using two-dimensional hydrodynamic modeling to assess the influence of ice processes on channel geomorphology. CSDA recommends that the investigators prepare for licensing participant review a formal presentation describing this framework and process.

CSDA states that the proposed project has a high potential to alter the roles that LWD plays in shaping channel planform, and that the RSP does not explicitly state whether the two-dimensional modeling tools under consideration have the capability to incorporate large obstructions of the sizes and shapes that LWD might present. CSDA recommends that AEA prepare, for licensing participant review, a formal presentation to show how information on LWD dynamics would be used to estimate these potential project effects.

Discussion and Staff Recommendation

AEA acknowledges that ice can directly influence channel morphology and that the potential effects of project operation on ice processes is an issue that needs to be addressed in fluvial geomorphology modeling. AEA identifies the following five ways that the influences of ice processes may be incorporated directly into fluvial geomorphology modeling:

1) simulating the effects of surges from ice jam break-up on hydraulics, sediment transport, and erosive forces using unsteady-flow two-dimensional modeling with estimates of breach hydrographs;

2) simulating the effect of channel blockage by ice on the hydraulic and erosion conditions resulting from diversion of flow onto islands and the floodplain;

3) using the two-dimensional model output to assess shear stress magnitudes and patterns in vegetated areas, and the likelihood of removal or scouring;

4) using the two-dimensional model output to assess shear stress magnitudes and patterns in unvegetated areas, and the likelihood of direct scour of the boundary materials; and

5) applying the two-dimensional model to investigate whether ice jams are a significant contributor to floodplain and island deposition as a result of ice jams inundating these features and causing sedimentation.

The RSP lacks sufficient information on the feasibility of implementing these five scenarios involving ice processes in geomorphic modeling, identifying which scenarios would be implemented, and specifying where and how each scenario would be implemented.

A stated goal of Study 6.5 (geomorphology) is to "Assess large woody debris transport and recruitment, their influence on geomorphic forms and, in conjunction with the Fluvial Geomorphology Modeling Study, effects related to the project." The RSP states that the LWD study component would be carried out "… in conjunction with the Fluvial Geomorphology Modeling Study to estimate potential project effects on large woody debris recruitment and associated changes in the processes that create and influence the geomorphic features linked to important aquatic habitats of the Middle and Lower River segments."

RSP section 6.5.4.9 includes study components that would use LWD characteristics mapped and measured as part of Study 6.5 (geomorphology), to: (1) establish channel roughness parameters for hydraulic modeling; (2) assess pre- and post-project bank erosion and associated LWD recruitment rates along the mainstem Susitna River; and (3) use two-dimensional modeling to predict the potential influences of variable LWD densities and hydrologic conditions on geomorphic features and associated aquatic habitats in focus areas. AEA states that these results would be provided to Study 8.5 (fish and aquatics instream flow) to estimate project-related changes in aquatic habitat indicators. We find that the RSP and associated supplementary filings adequately address characterization of LWD and potential recruitment of LWD from bank erosion in the Susitna River system, but that the RSP does not adequately describe where and how LWD would be implemented in two-dimensional geomorphic modeling.

As noted above in our analysis and recommendations for *Modeling in Focus Areas*, we are recommending that AEA file a technical memorandum with additional information on AEA's proposed model selection process. We recommend that an additional provision be added to the technical memorandum requiring that AEA describe in detail how ice and LWD would be incorporated into both one- and two-dimensional modeling approaches. The technical memorandum should explicitly state where and how each of the five scenarios for incorporating ice processes into one-dimensional and/or two-dimensional fluvial geomorphology modeling would be implemented, as well as details regarding where and how LWD pieces and/or accumulations would be incorporated into two-dimensional modeling.

Geomorphic Effects in the Lower River Segment

NMFS, FWS, CSDA, TNC, and TCCI state that the determination of the downstream extent of modeling explicitly needs to avoid simplistic assumptions about the potential for buffering of impacts below approximate RM 99. These commenters request that AEA state how the results of the *Reconnaissance-Level Assessment of Project Effects on the Lower and Middle River Segments* (RSP section 6.5.4.6) would be used to test hypotheses about the potential project effects on channel morphology below RM 84. CSDA further requests a formal peer-review of the process for determining the downstream extent of modeling and the study results. NMFS, FWS, and CSDA state that AEA appears biased in its qualitative predictions of potential geomorphic response to the proposed project downstream of the three rivers confluence.

Discussion and Staff Recommendation

AEA states in its Final Focus Area Tech Memo that, as a result of preliminary hydrologic and geomorphic studies, it would extend the investigation of the potential project-related effects downstream to the Susitna Station gage (RM 25.8), which is well downstream of RM 99. This investigation would include bed material and bed-load sampling and one-dimensional sediment-transport modeling to quantify the magnitude of potential project-related effects. AEA has adequately identified the potential for adverse project effects on geomorphology in the Lower River segment, and has adjusted the downstream extent of its proposed geomorphic investigations to provide more detailed assessment of these potential effects (section 5.9(b)(5)).

No modifications to the study plan are recommended.

Operational Scenarios

NMFS and FWS recommend that AEA use the two-dimensional bed evolution model in focus areas to assess the potential effects of alternative operating scenarios on macrohabitats, and that these potential effects be scaled up to the geomorphic reach to estimate the total impacts to particular macrohabitats. TNC recommends that all studies be evaluated for project operating scenarios that include baseline (no project), the proposed load following, various base load operations, and run-of-river operation. TNC states that a run-of-river scenario would allow assessment of the project on water quality, sediment transport and other anticipated effects.

Discussion and Staff Recommendation

Sections 6.6.4.2.2.1 and 6.6.4.2.2.2 of the RSP describe existing conditions - base case modeling and future conditions - with-project scenarios, respectively.
Sections 6.6.4.2.2.1 and 6.6.4.2.2.2 of the RSP state that all scenarios would be modeled with both the one-dimensional model to determine the reach-scale project effect and the two-dimensional to determine the local-scale project effects. The RSP adequately addresses the two-dimensional modeling recommendations made by NMFS and FWS.

Section 6.6.4.2.2.2 of the RSP presents three with-project scenarios that include: (1) maximum load-following; (2) intermediate load-following; and (3) base load. These with-project operational scenarios do not include run-of-river. A wide-range of project operations, as compared to existing conditions, would need to be evaluated in the EIS (section 5.9(b)(5)). The RSP does not provide an adequate range of project operation. Including run-of-river operation is reasonable and would improve the study at minimal cost or effort (section 5.9(b)(7)).

As discussed under the general comments section of this study plan determination, we recommend the study plan be modified to include run-of-river operation.

Groundwater Study (7.5)

Applicant's Proposed Study

AEA proposes to conduct a study to describe groundwater processes, and project effects on those processes, in portions of the Susitna River affected by project operations. For the purposes of this study, the river is divided into three study segments: Lower River (RM 30–98.5), Middle River (RM 98.5–184), and Upper River (RM 184–234). The primary goal of the study is to characterize the effects of the project on groundwater/surface-water (GW/SW) interactions at multiple spatial and temporal scales as they relate to aquatic and floodplain species in the Middle River and in the lowermost portion of the Upper River near the proposed dam site. Additionally, one task is focused on evaluating the potential effects on shallow groundwater well users in the Middle River and Lower River segments. This study would interact with and support a number of other studies in providing data, references, and process characterization of GW/SW interactions to help determine the potential effects of project operation on various natural resources, such as riparian and aquatic, and the public.

Proposed methods for the study are summarized below.

1) Synthesize historical and contemporary groundwater data available for the Susitna River groundwater and groundwater-dependent aquatic and floodplain habitat, including that from the 1980s, other cold region studies, and other studies related to this project.

2) Use the available groundwater data to define large-scale geohydrologic units and relate them to process-domains/terrain of the Susitna River (e.g., geology, topography, geomorphology, regional aquifers, shallow groundwater aquifers, and GW/SW interactions).

3) Construct conceptual GW/SW models to assess the potential effects of the Watana dam/reservoir on groundwater and groundwater-influenced aquatic habitats in the vicinity of the proposed dam.

4) Work with other resource studies to map groundwater-influenced aquatic and floodplain habitat (e.g., upwelling areas, springs, groundwater-dependent wetlands) within the upper portion of the Lower River segment

and the Middle River segment, including habitat within selected Middle River focus areas.

5) Determine the GW/SW relationships of floodplain shallow alluvial aquifers within selected focus areas as part of Study 8.6 (riparian instream flow). The overall goal of this study component would be to collect information and data to define GW/SW interactions and relationships to riparian community health and function at a number of focus area locations so results could be used to scale up to other locations in the river. These relationships would then allow for a determination of how project operations may influence GW/SW interactions and the riparian communities at unmeasured areas. Development of physical groundwater models at focus areas applicable for evaluating riparian community structure would help to understand the influence of these relationships. Physical models, including surface water hydraulic (1-D and 2-D), geomorphic reach analyses, GW/SW interactions, and ice processes, would be integrated such that physical process controls of riparian vegetation recruitment and establishment could be quantitatively assessed under both existing conditions and different project operations. The focus areas for this study component would be limited to those exhibiting GW/SW interactions that relate to the ecology of riparian and/or aquatic habitats pending further evaluation of each of the focus areas.

6) Determine GW/SW relationships of upwelling/downwelling in relation to spawning incubation, and rearing habitat (particularly in the winter) within selected focus areas as part of Study 8.5 (fish and aquatics instream flow). The same general approach as described above for the riparian component would be used for evaluating GW/SW interactions within aquatic habitats for Study 8.5. Habitat Suitability Criteria (HSC) and a Habitat Suitability Index (HSI) would be developed that include groundwater-related parameters (upwelling/downwelling). The focus areas for this study component would be limited to those exhibiting GW/SW interactions that relate to the ecology of riparian and/or aquatic habitats pending further evaluation of each of the focus areas.

7) Characterize water quality of selected upwelling areas that provide biological cues for fish spawning and juvenile rearing in focus areas as part of Study 8.5. At selected instream flow, fish population, and riparian study sites, basic water chemistry data (temperature, dissolved oxygen, conductivity, pH, turbidity, redox potential) would be collected that define

habitat conditions and characterize GW/SW interactions. Water quality differences would be characterized between a set of key productive aquatic habitat types (three to five sites) and a set of non-productive habitat types (three to five sites) that are related to the absence or presence of groundwater upwelling to improve the understanding of the water quality differences and related GW/SW processes.

8) Characterize the winter flow in the Susitna River and how it relates to GW/SW interactions. Water levels/pressure would be measured at the continuous gaging stations on the Susitna River during winter flow periods. Winter discharge measurements would be used to help identify key sections of the main stem with groundwater baseflow recharge to the river (upwelling). In focus areas, channel/slough temperature profiles would be measured to help characterize the GW/SW interactions and temporal variations over the winter flow season.

9) Characterize the relationship between the Susitna River flow regime and shallow groundwater users (e.g., domestic wells), and assess their susceptibility to project effects.

Comments on the Study

Existing Data Synthesis

NMFS requests that the literature review include studies of hydroelectric project effects on surface water/groundwater interactions in cold regions.

Discussion and Staff Recommendation

AEA does not explicitly state that surface water/groundwater interactions would be reviewed for cold-region hydroelectric projects. Including relevant sites is reasonable and would improve the study at minimal cost or effort (section 5.9(b)(7)).

We recommend that AEA include relevant projects in the literature review.

Conceptual Regional Hydrogeologic Model Development

NMFS and FWS state that the development of the conceptual model should include investigation of Susitna Valley depositional environments.

NMFS and FWS request that the hydrogeologic framework incorporate borehole lithologic data and groundwater-level data (where available) from both regional and shallow groundwater aquifers. The additional data would contribute to a three-dimensional distribution of hydrogeologic units, comparison of geochemical data from boreholes in different parts of the study area to infer groundwater flow paths, comparison of time-series groundwater data from wells in different aquifer units, construction of a regional-scale water table map and/or potentiometric surface, and estimation of a groundwater budget.

Discussion and Staff Recommendation

AEA proposes to characterize the regional hydrogeologic framework in accordance with ASTM standard D5979 (ASTM, 2008a) which is consistent with generally accepted practices in the scientific community (section 5.9(b)(6)), and should provide the information necessary to characterize the regional hydrogeologic system. The information requested by NMFS and FWS appears to be consistent with these standards and therefore would not require a change to the RSP.

No modifications to the study plan are recommended.

Lateral Extent of Study Area

FWS requests that the study area include a description of the lateral boundary and recommends a definition selected in collaboration with the TWG that includes a combination of surface-water flooding, groundwater potentially influenced by project operation, and the current riparian plant communities.

Discussion and Staff Recommendation

The lateral extent of the groundwater study area is defined within the context of the regional hydrogeologic system, and the portion of that system that would be evaluated for project impacts would be determined on the basis of field studies in combination with groundwater modeling evaluations. AEA proposes to characterize the local groundwater systems in accordance with the applicable ASTM standards and by using the techniques described in the USGS WRI Report 98-4088 (Nakanishi and Lilly, 1998) which are consistent with generally accepted practices in the scientific community (section 5.9(b)(6)), and should provide the information necessary to determine the lateral groundwater system boundaries.

No modifications to the study plan are recommended.

Accuracy Assessment of Groundwater Model Upgradient Boundaries

NMFS and FWS request an assessment of the precision and accuracy of the linkage from hydrogeologic units to river reaches. The agencies suggest that one way to address this concern would be to undertake a sensitivity analysis of upgradient-specified head boundaries at the floodplain margins for areas where detailed numerical modeling is employed.

Discussion and Staff Recommendation

AEA proposes to characterize the local groundwater systems in accordance with the applicable ASTM standards and by using the techniques described in the USGS WRI Report 98-4088 (Nakanishi and Lilly, 1998. It is our understanding that the USGS method would provide information on both aquifer state and boundary properties, and the ASTM methods provide additional guidance for developing and evaluating the accuracy of a groundwater flow model including such methods as suggested by NMFS and FWS, if necessary. Therefore, the methods proposed in the RSP are consistent with generally accepted practices (section 5.9(b)(6)), and should provide the information necessary to characterize the local groundwater systems.

No modifications to the study plan are recommended.

Groundwater Model Boundary Condition Uncertainty

FWS requests that uncertainty be evaluated in boundary conditions at the lateral boundaries (e.g., river main stem, floodplain margins) and the vertical boundaries (e.g., areal recharge and vertical water flux beneath the floodplain) of focus areas. Particular issues of concern expressed by FWS include groundwater level impacts caused by changes in channel morphology (e.g., incision or lateral migration) or external influences such as regional groundwater dynamics. FWS recommends that AEA develop a basin-scale groundwater or integrated hydrologic model, or that a set of plausible future groundwater-level fluctuations at the lateral boundaries of the alluvial aquifer be defined based on existing hydrogeologic data. FWS contends that a model sensitivity analysis could then be conducted with the floodplain groundwater flow model, varying the prescribed heads within the reasonable range of groundwater levels.

Discussion and Staff Recommendation

AEA proposes to characterize the local groundwater systems in accordance with the applicable ASTM standards which are consistent with generally accepted practices in the scientific community (section 5.9(b)(6)), and should provide the information necessary to characterize the local groundwater systems. If impacts due to other processes (e.g., geomorphology) or factors (e.g., pumping wells) are predicted as a result of project effects, then the boundary conditions, whether internal or external, would have to be adjusted in accordance with those standards. The additional analysis requested by FWS is not necessary to meet the study objectives.

No modifications to the study plan are recommended.

Site-Specific Groundwater Network Schematics

FWS requests that focus area-specific networks showing the placement of wells and other data collection station types be reviewed by the TWGs and the schematics be included in the final study plan. FWS states that other areas where groundwater studies are planned should also have site-specific networks reviewed by the TWGs and their schematics included in the final study plan.

Discussion and Staff Recommendation

The RSP states, “Both generic and interpretative models will be used to help improve process understanding and design of data collection field programs, and for developing the framework for predictive models that will simulate Project effects.” The framework would therefore be designed as an iterative process in which collected data is evaluated to determine whether the network needs to be refined in order to adequately characterize the system. For this reason, it would be premature to include final network designs in the study plan. Thus, AEA’s study is consistent with accepted methods (section 5.9(b)(6)), and would provide information necessary to support the design of the project, assess environmental effects, and evaluate proposed environmental measures.

No modifications to the study plan are recommended.

Focus Area Groundwater/Surface Water System Characterization

NMFS and FWS request the addition of stable isotopes of water to the existing suite of water quality parameters in the data collection program. The agencies assert that it is likely that regional groundwater and river water from the mainstem have distinct isotopic signatures, allowing for the construction of two-component mixing models.

NMFS and FWS also request that vertical temperature profiles be measured at focus areas used by anadromous species (not just in areas where groundwater upwelling is suspected), and that the vertical exchange between surface and groundwater be estimated from these measurements. The agencies recommend installing self-contained data loggers which could provide the data needed for vertical flux estimation. The agencies assert that the collection of vertical temperature profiles and estimation of vertical fluxes would assist in characterizing zones of groundwater upwelling and quantifying vertical water fluxes.

NMFS and FWS further request that multilevel or nested piezometers be installed in the riverbed in focus areas in order to characterize shallow, intermediate, and regional exchange. The agencies also request that water quality data (i.e., dissolved oxygen, specific conductance, etc.) be used to assist in the interpretation of time-series groundwater level records from the piezometer arrays. The agencies also suggest including multiple measurement methods (e.g., Kikuchi et al., 2006) to improve the interpretation of the water-level data.

NMFS and FWS also request that flux through the riverbed be determined, either through inverse modeling or by performing slug tests to determine hydraulic conductivity.

<u>Discussion and Staff Recommendation</u>

AEA proposes to characterize subsurface systems using a variety of techniques in accordance with ASTM and USGS standards and practices, which are consistent with generally accepted practices in the scientific community (section 5.9(b)(6)). It is possible that the complexities of the system and heterogeneity of local stratigraphy cannot be adequately characterized by the methods initially proposed by AEA and additional methods, such as those recommended by the agencies, would be required. However, until wells are installed and initial characterizations are made, it would be premature to require such measures. There are numerous provisions within the ILP prefiling study plan implementation process that allow for an evaluation of the effectiveness of AEA's initial study methods, and appropriate study modifications could be proposed by AEA or requested by the agencies, following the initial evaluation. The first of these opportunities occurs after the filing of the initial study report (sections 5.15(c)(2) and 5.15(c)(4)).

No modifications to the study plan are recommended.

Water-Level Depth Uncertainty

Assuming that Light Detection and Ranging (LiDAR) would be used, FWS recommends that LiDAR error along with the sensitivity analysis for MODFLOW be used to calculate the combined error for the water-level depth. If this error approaches 20 centimeters or more, then FWS requests a TWG meeting to discuss other options for predicting riparian community response to project operations.

Discussion and Staff Recommendation

The issue of assessing uncertainty associated with the analysis results is integral to the methods proposed and would be considered a standard method, consistent with generally accepted practices in the scientific community (section 5.9(b)(6)). Whether 20 centimeters is the appropriate level of depth measurement precision, or a different measurement precision should be considered, would be determined through consultation on the final proposed methods, as explained below under *Evapotranspiration Model*, comments. Additionally, there are numerous provisions within the ILP prefiling study plan implementation process that allow for an evaluation of the effectiveness of AEA's study methods, and appropriate study modifications could be proposed by AEA or requested by the agencies, following their evaluation. The first of these opportunities occurs after the filing of the initial study report (sections 5.15(c)(2) and 5.15(c)(4)).

No modifications to the study plan are recommended.

Evapotranspiration Model

FWS states that the data requirements for the MODFLOW riparian-evapotranspiration package (RIP-ET) are substantial, requiring extensive geospatial delineation of plant functional groups (with respect to water use) and determination of transpiration flux curves for each group. FWS asserts that defining meaningful site-specific curves would require measurements throughout the growing season for up to several years or more, and suggests the need to dig up roots to determine their maximum depth which they state is notoriously very difficult. FWS questions how these data would be acquired and whether they could adequately define the flux curves required by the models.

Discussion and Staff Recommendation

RIP-ET requires two primary sets of input data: (1) the geospatial delineation of plant functional subgroups, and (2) transpiration flux curves specific to those groups. AEA proposes to collect data as a part of Study 11.6 (riparian vegetation) that could be used to define plant functional subgroups. However the RSP does not describe the methods that would be used to relate the data of Study 11.6 to functional groups, nor does it reference standards for doing so.

Definition of flux curves requires that the shape of the curve and extinction and saturated extinction depths be determined. The RSP (8.6.3.6.3) describes how rooting depth would be determined but does not describe how this information would be used to determine extinction depths or saturated extinction depths. Additionally, the RSP does not describe how the shape of the curves would be defined. No standards or procedures are referenced as the basis for defining the transpiration flux curves.

We recommend that AEA consult with the TWG on the construction of the necessary data sets for the MODFLOW RIP-ET package, and file no later than June 30, 2013, the following:.

1) A detailed description of the specific methods to be used to relate the data of Study 11.6 (riparian vegetation) to plant functional groups.

2) A detailed description of the specific methods to be used to relate the rooting depth data from Study 8.6 (riparian instream flow) and the water level data from Study 7.5 (groundwater) to extinction and saturated extinction depths.

3) A detailed description of the specific methods to be used to estimate the shape of the transpiration flux curves.

4) Documentation of consultation with the TWG, including how its comments were addressed.

Focus Area Groundwater Model Integration with Open-Channel Flow Routing Model

NMFS and FWS request clarification on the steps and methods required to develop a groundwater model to forecast the effects of dam operation on floodplain and aquatic focus area water-table elevations. FWS also requests that the integration of groundwater and open-channel flow routing models be explicitly described.

Discussion and Staff Recommendation

AEA proposes to select the appropriate MODFLOW modeling package for computing groundwater/surface water interaction using ASTM D6170 (ASTM, 2010). This approach is consistent with generally accepted practices in the scientific community and we expect that the clarification requested by the agencies would be provided in accordance with accepted methods (section 5.9(b)(6)) when the initial study report is submitted.

No modifications to the study plan are recommended.

Groundwater Model Uncertainty

FWS recommends conducting a model uncertainty-analysis of the aquifer hydraulic properties by assigning confidence intervals on the estimated parameters such as aquifer transmissivity, specific yield, anisotropy, and riverbed conductance.

Discussion and Staff Recommendation

AEA proposes to develop calibration goals and procedures for the groundwater models in accordance with ASTM standard D5981 (ASTM, 2008b) which is consistent with generally accepted practices in the scientific community (section 5.9(b)(6)), and should provide the information necessary to characterize the regional hydrogeologic system.

No modifications to the study plan are recommended.

Relation of Ice Processes to Focus Areas Riverbed Flux

NMFS and FWS request that ice process characterization be related to GW/SW exchange quantification in the focus areas. The agencies also request that a framework be developed to assess project effects during winter on groundwater by integrating changes in instream flow hydraulics with changes in ice. The agencies further request the calculation of GW/SW fluxes to characterize the fluxes during winter months under baseline conditions.

Discussion and Staff Recommendation

AEA proposes to select the appropriate MODFLOW modeling package for computing GW/SW interaction using ASTM D6170 (ASTM, 2010) which includes modeling groundwater effects due to ice processes. MODFLOW is a three-dimensional groundwater flow model and it is our understanding that flux at the GW/SW interface would be a numerical output of the model. AEA's proposed approach is consistent with generally accepted practices in the scientific community (section 5.9(b)(6)), and should provide the information necessary to evaluate GW/SW exchange and potential project effects on riverbed flux (section 5.9(b)(5)).

No modifications to the study plan are recommended.

Relation of Ice Processes Backwater to Surface/Groundwater Exchange

NMFS and FWS request that the data products from the ice processes study be linked to the observations of floodplain and aquatic groundwater levels near different types of river-ice formations, allowing for qualitative upscaling of data from the focus areas. The agencies request that ice process characterization be related to GW/SW exchange quantification in the focus areas and that a framework be developed to assess project effects during winter on groundwater by integrating changes in instream flow hydraulics with changes in ice.

Discussion and Staff Recommendation

As stated in section 7.5.4.4 of the RSP, AEA already proposes to quantify riparian vegetation dependency on GW/SW interactions, and notes that there would be interdependencies and integration of numerous physical process studies and models, including this study and Study 7.6 (ice processes) to evaluate upwelling/springs broad-scale mapping, riparian vegetation dependency on GW/SW interactions, aquatic habitat GW/SW water interactions, and winter GW/SW water interactions.

While the RSP does not explicitly state that the specific evaluations requested by the agencies would be conducted, the methods and models proposed would allow for such assessments in the future. It is still uncertain whether or where project effects would significantly impact changes to GW/SW interactions under the different operating scenarios; therefore, it would be more effective to wait until such effects are determined before making further evaluations.

Thus, AEA's study is consistent with accepted methods (section 5.9(b)(6)), and should provide information necessary to support the design of the project, assess environmental effects, and help inform the development of license requirements (section 5.9(b)(5). As noted above, there are numerous provisions within the ILP prefiling study plan implementation process that allow for an evaluation of the effectiveness of AEA's initial study methods, and appropriate study modifications could be proposed by AEA or requested by the agencies, following the initial evaluation. The first of these opportunities occurs after the filing of the initial study report (sections 5.15(c)(2) and 5.15(c)(4)).

No modifications to the study plan are recommended.

Reservoir Perimeter Fluctuating Inundation

FWS requests that the study plan describe the lateral extent and duration of inundations for all fish-bearing tributaries to the proposed reservoir (not just at the upstream end) and provide examples of differing perimeter side slopes around the reservoir.

Discussion and Staff Recommendation

Inundation of tributaries through reservoir creation would result in permanent modification to reservoir tributaries, some of which support resident and anadromous fish spawning, rearing, and migration habitats. However, an evaluation of reservoir tributary inundation appears to be unrelated to the groundwater study. Information to describe the extent of tributary and fish habitat modification through dam and reservoir creation would be addressed in numerous other studies including Study 9.10 (reservoir fish community), Study 9.5 (upper river fish distribution), and Study 9.9 (aquatic habitat mapping).

No modifications to the study plan are recommended.

Ice Processes in Susitna River Study (7.6)

Applicant's Proposed Study

AEA proposes to conduct a study to describe ice processes in the Susitna River and provide a method to model and predict those processes pre-project and post-project. For the purposes of this study, the river is divided into three study segments: Lower River (RM 0–100), Middle River (RM 100–184), and Upper River (RM 184–233.4). The primary goal of the study is to provide a basis for assessing the impact of project operations on downstream ice processes, which would inform the development of any necessary protection, mitigation, and enhancement measures. The study would also provide ice process input data for other resource studies with winter components (e.g., Study 6.6 (geomorphology modeling), Study 8.5 (fish and aquatics instream flow), Study 8.6 (riparian instream flow), and Study 7.5 (groundwater)).

Proposed methods for the study are summarized below.

1) Document the timing, progression, and physical processes of freeze-up and break-up during 2012–2014 in the Upper River, Middle River, and Lower River segments using the following methods.

a. Perform aerial reconnaissance and global positioning system (GIS) mapping of ice features, including ice jams, ice bridges, frazil ice accumulations, and open leads during the break-up and freeze-up periods. AEA anticipates that approximately 10 reconnaissance trips per spring would occur during break-up, and 15 reconnaissance trips per winter would occur during freeze-up.

b. Perform time-lapse camera monitoring of break-up and freeze-up at locations corresponding to flow routing model instrumentation, key ice processes, and fish habitat locations. The cameras would be located at approximately 28 locations.

c. Collect winter field data at 13 transects identified for the flow routing model study and used to calibrate the existing condition ice processes model. The data would include total and submerged ice thicknesses, slush ice thickness (January and March), top-of-ice elevation, air temperature, water temperature, water stage, discharge, and snow cover thickness.

d. Collect winter field data in focus areas, including ice thicknesses, elevations, and water depths sufficient to characterize the ice cover, and calibrate a detailed model of the short focus area reaches. Freeze-up timing and processes, the presence of open leads, and historical ice jam processes would be characterized for each site to further understand how winter conditions affect fish habitat and geomorphology. The focus areas would be determined in conjunction with the instream flow habitat and riparian studies.

e. Collect data that would also be used for Study 8.6 (riparian instream flow), including tree scars and floodplain disturbance by ice, to delineate locations of significant ice events. Additionally, the results of Study 8.6 would be used to delineate reaches of the river where ice processes, primarily break-up jams, have occurred in the past.

2) Develop a predictive ice, hydrodynamic, and thermal model of the Middle River for existing conditions using the River1D[17] model to simulate time-

[17] River1D is a one-dimensional hydrodynamic flow routing and thermal model developed by the University of Alberta River Ice Engineering Program (Andrishak and Hicks, 2005a and 2005b; Hicks, 2005; Hicks and Steffler, 1992; She and Hicks, 2006; She et al., 2009; She et al., 2012).

variable flow routing, heat-flux processes, seasonal water temperature variation, frazil ice development, ice transport processes, and ice-cover growth and decay. The model would be calibrated as an open-water model using known discharge events and then verified using pre-project ice data from the 1980s and data collected as part of the study for a range of climate conditions.

3) Use the River1D model to simulate conditions in the Middle River due to various project operating scenarios and predict changes in water temperature, frazil ice production, ice cover formation, elevation and extent of ice cover, and flow hydrograph. The model would also predict ice cover stability, including potential for jamming, under load-following fluctuations. For the spring melt period, the model would predict ice-cover decay, including the potential for break-up jams. Proposed operating scenarios would include, at a minimum, the load-following scenario described in the Pre-Application Document (PAD) and a base-load scenario.

4) Develop detailed models and characterizations of ice processes for selected Middle River focus areas using either River1D or River2D[18] models. The model would be selected on the basis of which model better simulates the characteristics at the particular study location. The objective of this modeling would be to evaluate project effects on smaller scale habitat in the focus areas to provide physical data on winter habitat for Study 8.5 (fish and aquatics instream flow). The selected focus areas would be determined in conjunction with instream flow habitat and riparian studies.

5) Assess model accuracy and sources of error to evaluate the errors associated with measuring input data, estimating Manning’s N under ice, and interpolating measured values over distances.

6) Assess the potential for change to ice cover on the Lower River both for fish habitat studies and an assessment of the potential effects of the project on winter transportation access and recreation. Project effects on the Lower River would be determined based on the magnitude of change seen at the downstream boundary of the River1D model, the estimated contributions of frazil ice to the Lower River from the Middle River from observations and

[18] River2D is a two-dimensional hydrodynamic flow routing and thermal model developed by the University of Alberta River Ice Engineering Program (Steffler, 2002).

modeling, and with simpler steady flow models (HEC-RAS with ice cover) for short sections of interest in the Lower River.

7) Review and summarize large river ice processes relevant to the Susitna River, analytical methods that have been used to assess impacts of projects on ice-covered rivers, and the known effects of existing hydropower project operations in cold climates.

Comments on the Study

Literature Review

Rebecca Long states that the literature review should be expanded to include other international project sites and other large non-hydro instream infrastructure.

Discussion and Staff Recommendation

AEA does not explicitly state that the literature review would include projects outside of North America although it is implied. The inclusion of large non-hydro instream project studies that may be applicable to this project is a reasonable extension of the scope that could potentially benefit the analysis at minimal cost or effort (section 5.9(b)(7)).

We recommend that AEA include relevant international and non-hydro sites in the literature review.

Study Duration

NMFS and FWS state that a study duration longer than two years is required to capture the natural range in ice process variability and asserts that a minimum of three years would be required. The agencies recommend that the RSP include a regional climate analysis sufficient for defining the range of meteorological conditions for study and to "help identify analogue observation years or to synthesize an analogue year."

Talkeetna Community Council, Inc. (TCCI) requests that three years of data collection ("meteorological conditions, climate analysis, ice thickness, ice progression, and break up events under ice discharge") be added to the study duration currently proposed by AEA.

Discussion and Staff Recommendation

AEA proposes to collect ice thickness and elevation data over two complete seasons, and freeze-up, open lead, and break-up data over three seasons. Additionally, the model would be verified for differing climate conditions using 1980s data, and it would be updated using 2013 or 2014 data if necessary. Given the volume of existing data and the level of detail of the data proposed to be collected, there is nothing to suggest that the proposed level of effort for developing the model would not be able to adequately represent a full range of climate conditions for the study (section 5.9(b)(7)).

We further address study duration in the general comments section of this study plan determination and we address general climate analysis in our February 1, 2013, study plan determination.

No modifications to the study plan are recommended.

Study Method Framework

NMFS and FWS request that a study framework be developed that would illustrate how the objectives of the ice processes study would be met through specific data collection programs and modeling or analytical tools. In those instances where analysis may be particularly challenging (e.g., complex channels in the lower reach), the agencies contend that a framework would help to map out a method of analysis where the application of the one-dimensional or two-dimensional model is limited. Also, the agencies request that the RSP clearly identify the deficiencies associated with each assessment tool and model and the corresponding strategy to address these deficiencies.

Discussion and Staff Recommendation

AEA has explained the data collection programs and analytical methods in sufficient detail to identify the relationship between the various study components and assess, at least initially, whether the proposed method of analysis is appropriate. AEA has proposed methods and models that are within accepted scientific practice (section 5.9(b)(6)) and any potential deficiencies would be identified and addressed, as appropriate, as an ongoing part of the study.

No modifications to the study plan are recommended.

Upstream Modeling

NMFS and FWS state that the methods and/or tools for assessing project impacts upstream of the reservoir are not described in the study plan.

Rebecca Long states that modeling must be conducted in the upstream tributaries.

Discussion and Staff Recommendation

AEA is not proposing to characterize ice processes or evaluate related project effects upstream of the dam, either in the Upper River mainstem or its tributaries. However, there is no supporting information supplied by either commenter as to why such an evaluation would be necessary or how it would assist with the development of license requirements (section 5.9(b)(5)). Maintaining the study focus on project effects downstream of the proposed dam site, as proposed by AEA, would sufficiently inform the environmental analysis and development of license conditions needed to protect environmental resources.

No modifications to the study plan are recommended.

Ice Process Information Vetting

NMFS and FWS request that the study plan identify a task where ice process data and information received from other studies are reviewed and vetted by an experienced river ice expert, resulting in a description of the quality of data and why it is applicable.

TCCI supports the agencies' requests for ice process data and related studies to be reviewed and vetted by an experienced river ice expert. TCCI asserts that a reliable synthesis of winter impacts is of paramount concern to its service area.

Discussion and Staff Recommendation

There is no information to suggest that the information would not be shared and vetted among experts and study team members as stated in the study plans. We consider this to be part of the standard QA/QC process that would be employed by the study team.

No modifications to the study plan are recommended.

Additional Time-Lapse Camera Locations

NMFS and FWS state that there is a large gap in planned camera locations between RM 25.6 and RM 101. Because no modeling would be done in this reach to interpolate between these locations, they request that there be more observations in this reach.

Alaska DNR states that Susitna Landing at the mouth of the Kashwitna River should be considered as a camera location because it has power and serves as the location of multiple over-ice easements across the Susitna River.

Discussion and Staff Recommendation

The Susitna Landing location recommended by Alaska DNR is a few miles upstream of the camera location at the Rustic Wilderness Side Channel (RM 59), which is proposed to be discontinued by AEA in the 2013 study season. The addition of a camera at Susitna Landing would be a low cost measure (section 5.9(b)(7)) that would be beneficial for maintaining observations near the current Rustic Wilderness camera location, as well as adding additional ice monitoring between RMs 25.6 and 101, where there is currently only limited coverage.

We recommend that an additional camera be added at Susitna Landing.

Open Water Leads Temperature Data Collection

NMFS and FWS suggest that the field program should consider measuring temperature in open water leads[19] to facilitate calibration of the model's predicted temperatures at open water leads for different flow/operation scenarios.

Discussion and Staff Recommendation

We are not aware of any information to suggest that collection of additional data on water temperatures in open water leads would be necessary to meet the study objectives. Instead, an assessment of data adequacy should be made using the data already collected by AEA to calibrate the ice models. If the calibration and validation process does not result in an acceptable model, then an evaluation of the usefulness of open water lead temperature data can be made to determine whether there would be benefit in collecting these data during the next data collection season (sections 5.15(d) and 5.15(e)).

No modifications to the study plan are recommended.

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[19] Open water leads are elongated openings in the ice cover caused by water current (velocity lead) or warm water (thermal lead).

Ice Data Collection Frequency

NMFS and FWS contend that, because the study period is short and the nature of the study is difficult, ice progression, thickness, and open leads in the study areas need to be observed frequently enough to capture mid-winter changes, such as occurred during the winter of 2012-2013, where ice-up occurred and a warm spell altered the ice cover and associated changes in river hydraulics followed. The agencies request that an additional set of ice thickness and elevation measurements be collected in February of each year.

TCCI states that the high water event of 2012 and the November 2012 warming event caused large ridges of ice to be transported in the vicinity of the three rivers confluence. TCCI asserts that the study does not address random meteorological events or their effects on ice and would like to see a component added which incorporates documenting and evaluating these conditions.

Discussion and Staff Recommendation

The study period proposed by AEA includes two complete and two partial study seasons, as well as an evaluation of the data collected during the 1980s studies. There is no information to suggest that AEA's proposed level of effort together with existing information would not be adequate to characterize ice processes and their associated variability for the purposes of quantifying project effects. AEA's proposed phased approach of collecting data and then using those data to calibrate the ice model is reasonable and consistent with similar evaluations completed in the context of hydroelectric licensing cases (section 5.9(b)(6)). If the results of the 2013 and 2014 study seasons (as documented in the initial and updated study reports) indicate that the model is not sufficiently accurate to adequately evaluate project effects, additional data collection could occur in 2014 or in subsequent study years (sections 5.15(d) and 5.15(e)).

No modifications to the study plan are recommended.

Open Water Lead Data Collection

NMFS and FWS request that open lead locations be documented during the January and February data collection programs to determine if open leads persist in the winter period.

Discussion and Staff Recommendation

In regard to an additional open-lead aerial survey in January, AEA is proposing to conduct field measurements during January to measure ice thickness during freeze up conditions. However, it does not propose to conduct aerial observations at the same time as the field data collection event. An additional reconnaissance flight to document open leads in January at the same time as the field data collection event could substantially improve the characterization effort (section 5.9(b)(6)) by supplying open lead information for comparison with two-dimensional model results at the same time that the transect data is collected for the one-dimensional model calibration and verification. This would provide potential corroborating information to support the ability of the two-dimensional model to predict ice conditions. We estimate that the additional cost to conduct one additional aerial observation would be $7,000 to $14,000 for each year of data collection (section 5.9(b)(7)).

In regard to an additional February aerial survey, AEA does not propose to collect field data in February for one-dimensional model calibration and, as noted above in our analysis and recommendations for *Ice Data Collection Frequency*, we do not recommend any additional field data collection during the month of February. Because we do not recommend additional field data collection in February, there would be few additional benefits for conducting additional aerial observations of open leads during the same time period, and the minimal benefits would not justify the anticipated $7,000 - $14,000 cost for the additional aerial survey (section 5.9(b)(7)).

We recommend that AEA conduct one additional reconnaissance flight in January to document open leads at the same time as the field data collection to document freeze up conditions.

Ice Thickness Measurements

NMFS and FWS state that the 2012 Ice Processes Study report notes that ice thickness measurements were not taken due to safety concerns. They question how these safety concerns would be addressed in the future to ensure the collection of ice thickness data and whether, based on 2012 field experience, there are specific locations or conditions where the collection of ice thickness data is prohibitive.

Rebecca Long states that these measurements are necessary and there must be a safe way to collect them.

<u>Discussion and Staff Recommendation</u>

AEA has not indicated how it proposes to overcome its inability to collect the data, and we note that the data were proposed for use in calibrating the model for breakup conditions, an effort that was supposed to begin in the first quarter of 2013. Ice thickness data are critical for developing the model that would be used to evaluate project effects on ice processes. If ice thickness and elevation measurements are not collected in the spring of 2013 (and documented in the initial study report), then additional data collection attempts may need to be made during the winter and spring of 2014 or in subsequent study years (sections 5.15(d) and 5.15(e)).

No modifications to the study plan are recommended.

Number of Data Collection Transects

NMFS and FWS assert that the 13 transects proposed for field data collection in the RSP are far too few and requests that each of the open-water period flow-routing transects be included in ice thickness and winter flow measurements, at least initially until it can be shown from measured information that some transects may represent others in the same reach. The agencies request that a sensitivity analysis be added to the RSP to address this issue and that, at a minimum, the number of transects used in the open-water flow model from study 8.5 (fish and aquatics instream flow) be utilized for ice data collection.

TCCI supports the agencies' requests for additional transects.

Discussion and Staff Recommendation

The model calibrated in 1984 (Harza-Ebasco, 1984) was based on data from between 8 and 12 transect locations. Therefore, AEA's phased approach of first collecting data and then using those data to calibrate the ice model is a reasonable approach that is consistent with similar evaluations completed in the context of hydroelectric licensing cases (section 5.9(b)(6)). If the results of the 2013 and 2014 study efforts in the Middle River (as documented in the initial and updated study reports) indicate that the model is not sufficiently accurate to adequately evaluate project effects, additional transects and/or other data collection measures could be added in 2014 or in subsequent study years (sections 5.15(d) and 5.15(e)).

No modifications to the study plan are recommended.

Characterization of the Lower Susitna River

NMFS and FWS state that the RSP does not describe how the Lower River segment would be adequately characterized nor does it indicate the methods to be used to assess the potential impacts of the project on ice processes in the Lower River. The agencies recommend a characterization approach similar to that proposed for the Middle River but suggests that the collection of similar if not more data would be required in the Lower River. The agencies assert that the methods and/or tools for assessing project impacts to the Lower River are not described and suggest that they may include analytical methods supported by a simplified application of the one-dimensional model.

Discussion and Staff Recommendation

Given the complex nature of the Lower River and the ability of ice models to approximate that complexity, a phased approach of first characterizing ice processes in areas upstream of the three rivers confluence to determine the extent of project effects in areas with larger flow fluctuations (i.e., the Middle River) is consistent with similar evaluations completed in the context of hydroelectric licensing cases (section 5.9(b)(6)). If the results of the 2013 and 2014 studies in the Middle River (as documented in the initial and updated study reports) indicate that the project would result in ice process effects unsuitable for the modeling approaches proposed by AEA (i.e., HEC-RAS with ice cover), then a modified approach can be developed, as appropriate, on the basis of that information.

No modifications to the study plan are recommended.

Ice Jam Evaluation

NMFS and FWS request that FERC include a framework to assess project effects on ice jams. This framework should answer the question: how would the frequency, magnitude, and location of breakup ice jams change due to project operations? The agencies request that the framework also incorporate the effects of groundwater inflows once the predicted ice jam locations have been identified.

Discussion and Staff Recommendation

AEA proposes to predict the potential for breakup jams under proposed project operations, but does not propose to specifically characterize the frequency, magnitude, and location of breakup jams as requested by the agencies.

The agencies provide no specific recommended methods or level of effort and cost for how the requested analysis could be completed (section 5.9(b)(7)), and we are not aware of any accepted scientific methods or predictive models (section 5.9(b)(6)) that could accurately predict the future frequency, magnitude, and location of breakup jams under either existing conditions or proposed operations.

No modifications to the study plan are recommended.

Upstream Frazil Ice Production

NMFS and FWS ask how frazil ice production upstream of the proposed dam would be assessed given that it is outside the proposed model domain.

Discussion and Staff Recommendation

Although AEA has not stated how this issue would be addressed in the study plan, we understand that ice models were calibrated and verified for the same domain in the 1980s. Therefore, we consider it to be within the state of the scientific practice to model the river as AEA has proposed and address these and other potential data deficiency issues as part of the calibration and verification process (section 5.9(b)(6)). If the results of the 2013 and 2014 study efforts (as documented in the initial and updated study reports) indicate that the model cannot be sufficiently calibrated to adequately evaluate project effects, additional data collection methods could be added in 2014 or in subsequent study years (sections 5.15(d) and 5.15(e)).

No modifications to the study plan are recommended.

Model Downstream Boundary Conditions

NMFS and FWS assert that the downstream boundary of the model is a specified boundary condition in terms of water levels and ice cover formation, presumably based on observations of existing conditions. They state that it is not clear how boundary conditions would be established for the downstream boundary for both the existing and post project conditions. The agencies ask what the confidence level is of the extrapolation of water levels and ice thickness into the lower reach due to project operations based on these observed conditions.

Discussion and Staff Recommendation

Our understanding is that NMFS and FWS are incorrect as to the downstream boundary condition. Water levels would not be specified but rather defined as a rating curve and "downstream boundary conditions for water temperature and ice conditions are not required as the finite element method employed in River1D uses the applicable 'natural' boundary conditions" (Hicks et al., 2006). The proposed conditions could therefore be evaluated at the downstream boundary of the model and compared with existing conditions as proposed by AEA.

No modifications to the study plan are recommended.

Downstream Ice Model

NMFS and FWS state that the methods for extending the HEC-RAS model with a simple ice cover model to assess ice processes in the lower reaches warrants further description. The agencies ask how a static representation of simple ice cover would be extended to describe dynamic ice processes.

Alaska DNR requests that the "short sections" of the Susitna River proposed for modeling with HEC-RAS with ice cover should be relatively non-braided sections with stable beds.

Alaska DNR requests that factors other than ice thickness and ice cover delay be considered. Alaska DNR states that, with fluctuating water levels, overflow may be increased as well as air gaps under ice, leading to weak ice for traditional trail routes.

<u>Discussion and Staff Recommendation</u>

AEA proposes to assess project effects on ice processes in the Lower River 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 would 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 would have to 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 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 there would be additional opportunities for evaluating the appropriateness of the downstream extent of the model after reviewing the initial modeling results in the initial and updated study reports.

No modifications to the study plan are recommended.

Existing Model Calibration

NMFS and FWS request a list of parameters that should be adjusted in the calibration process. The agencies also suggest that each calibration parameter must be independently quantified, and that the study plan does not describe how this would be done or what data collection is needed to conduct this quantification.

Discussion and Staff Recommendation

We expect that these parameters would be identified and the calibration process would be described in accordance with accepted methods (section 5.9(b)(6)) when the initial study report is submitted. AEA's study plan contains sufficient initial information to conclude that its proposed modeling approach and calibration methods are consistent with generally accepted practices in the scientific community (section 5.9(b)(6)) and, if effectively implemented, can satisfy the study objectives.

No modifications to the study plan are recommended.

Border Ice and Frazil Ice Assessment

NMFS and FWS request that this study include assessment of border ice including baseline processes and the project's impacts on border ice.

Sound Science (on behalf of CSDA) states that alterations to frazil ice formation and movement might affect the availability of suitably sheltered habitat for fish such as overwintering fry. It states that the study plan does not include field studies or modeling designed to address such questions, that potential alterations to frazil ice formation and movement are proposed for only one-dimensional modeling, and the implications of the model results for availability of sheltered habitat for overwintering fry would not be modeled at all. Therefore, it suggests that there is a need for expanded, two-dimensional modeling of frazil ice dynamics.

Discussion and Staff Recommendation

Border ice and frazil ice have the potential to affect the availability of sheltered habitat for overwintering fry. This undoubtedly occurs under existing conditions and the magnitude and timing of these effects could change during proposed project operation. As described above, AEA proposes to use the River1D model to evaluate project effects on frazil ice. The study plan does not mention border ice. According to Hicks et al. (2006), border ice growth was not considered in the earlier version of the one-dimensional model (River1D) nor was the River2D model capable of computing either border ice or frazil ice as of 2009 (Wojtowicz et al., 2009). Updated versions of these models or an alternate model such as CRISSP-2D may be required to evaluate these issues.

We recommend that AEA perform the analysis requested by NMFS, FWS and CSDA using updated versions of the proposed models (River1D and River2D) or a different model such as the CRISSP-2D model, if the proposed versions of the models are not capable of producing information to support border ice and frazil ice analyses. The one-dimensional model was not released to the public domain on January 1, 2013, as stated in the study plan; therefore, we cannot identify if there would be much additional effort or cost compared to what is proposed.

Model Adequacy for Predicting Proposed Conditions

NMFS and FWS question whether the proposed model would be able to adequately predict multiple cover reconsolidations due to extreme load following scenarios. The agencies further state that it is unclear if the ice model accounts for stresses in the solid portion of the ice cover and how the failure strength of the ice would be determined during breakup conditions. The agencies request that this be included in the study plan.

<u>Discussion and Staff Recommendation</u>

This issue would be more appropriately addressed once the magnitude of project effects are predicted by the ice model. Whether the ice model accounts for stresses in the solid portion of the ice cover and how the failure strength of the ice would be determined during breakup conditions is an issue that should be addressed, especially since details of the model have not been released.

No modifications to the study plan are recommended.

Model Accuracy Questions

NMFS and FWS request clarification on what data collection procedures would be implemented to ensure the accurate definition of the hydraulic conditions and ice conditions in near-bank ice/water interface zones in the focus areas. The agencies question whether River2D can accurately model the hydraulic conditions and ice conditions in these zones which are important for fish habitat. The agencies further question whether the model would address heat transfer between the water and the bed which they assert is important for groundwater inflows and may be particularly significant under extreme load following scenarios where beds are alternately submerged and then exposed to sub-freezing temperatures with the potential for significant icings that would block channels.

<u>Discussion and Staff Recommendation</u>

NMFS and FWS do not provide any specific recommendations for how AEA's proposed data collection and modeling methods should be modified to incorporate its recommended study questions and additional study elements and we therefore are unable to evaluate the merits of requiring any additional data collection methods to address these issues in the study plan. AEA's proposed modeling approach should provide the information necessary to describe project effects with respect to ice processes to a degree which is consistent with generally accepted practices in the scientific community (section 5.9(b)(6)) and, if effectively implemented, is expected to be able to satisfy the study objectives.

If the initial results of the 2013 or 2014 study seasons (as documented in the initial study report) indicate that the model does not adequately evaluate project effects, and it becomes clear on the basis of the results that other procedures should be followed in order to meet the study objectives, then alternative methods and/or procedures could be added in 2014 or in subsequent study years (sections 5.15(d) and 5.15(e)).

No modifications to the study plan are recommended.

Additional Ice-Specific Focus Areas

NMFS and FWS request that, in addition to the focus areas selected for other riverine process studies, the studies should select focus areas specific to ice processes to investigate potential project effects to ice jams, aquatic habitat, and off-channel hydraulics. The agencies request that the data products from the ice processes study be linked to the observations of floodplain and aquatic groundwater levels near different types of river-ice formations, allowing for qualitative upscaling of data from the focus areas.

Discussion and Staff Recommendation

AEA selected its proposed focus area sites based on an evaluation of data collection and modeling needs for all study disciplines. We therefore conclude that AEA's proposed focus area selection for the purposes of the ice processes study is consistent with accepted methods (section 5.9(b)(6)), and should provide information necessary to support the design of the project, assess environmental effects, and evaluate proposed environmental measures (section 5.9(b)(5)). If the agencies conclude that the initial study results or any other available study results suggest that it is still necessary to include additional ice-specific focus areas, they could be requested in 2014 or in subsequent study years after a showing of good cause as specified in sections 5.15(d) and 5.15(e) of the Commission's regulations.

No modifications to the study plan are recommended.

Operational Scenario Evaluation

NMFS and FWS state that scenarios to be evaluated for assessing project impacts should include various base load operations that minimize the difference between natural flow conditions and operating flows, including a run-of-river operation scenario.

Rebecca Long also requested that base flow regimes within the range of natural flows be considered.

Discussion and Staff Recommendation

AEA proposes to evaluate operating scenarios that would include, at a minimum, the load-following scenario described in the PAD and a base load scenario. As noted in the general comments section of this study plan determination, we expect AEA's modeling efforts to collect the information necessary to evaluate the full range of potential operating scenarios, including proposed load-following, run-of-river, base load, and any other reasonable operating scenarios. However, the RSP does not explicitly state that proposed operating scenarios would be compared with natural conditions to evaluate project impacts.

We recommend that the analysis include an evaluation of natural conditions, as well as a range of alternatives with the dam in place, including maximum load-following, run-of-river, base load, and any other reasonable operating scenarios, to assess project effects. Because the natural condition model would already exist, we expect that these costs would be minimal.

Fish and Aquatics Instream Flow Study (8.5)

Applicant's Proposed Study

AEA proposes a study specifically directed toward establishing an understanding of important biological communities and associated habitats, and the hydrologic, physical, and chemical processes in the Susitna River that directly influence those resources. Much of the work focuses on establishing a set of analytical tools and models for defining existing conditions, and evaluating how aquatic resources and processes would respond to a range of alternative project operations.

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 integration of 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.

General study objectives include the following:

1) Use the results of study 9.9 (aquatic habitat mapping) 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) Select study areas and sampling procedures to collect data and information to characterize, quantify, and model mainstem and off-channel habitat types at different scales. This would be completed via a collaborative process involving this study and numerous other studies (e.g., riparian instream flow, groundwater, geomorphology, water quality, and fish distribution).

3) Develop 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. Model results would provide input to other models proposed to evaluate the effects on specific habitat elements and aquatic resources.

4) Develop site-specific habitat suitability criteria (HSC) and habitat suitability indices (HSI) for various species and life stages of fish that are selected in consultation with the TWG.

5) Develop integrated aquatic habitat models to produce a time series of data for a variety of metrics under existing conditions and alternative operational scenarios. 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
- habitat suitability indices.

6) Evaluate 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 phases.

7) Coordinate instream flow modeling and evaluation procedures with other study efforts (e.g., riparian, geomorphology, groundwater, water quality, fish passage barriers, and ice processes).

8) Develop a decision support-system-type framework to conduct a variety of post-processing comparative analyses derived from the output metrics estimated under aquatic habitat models. These include, but are not limited to:

- 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.

The study area includes two Susitna River study segments: (1) Middle River from the Watana dam site (RM 184) downstream to the three rivers confluence area (RM 98.5),[20] and (2) Lower River from the three rivers confluence downstream to Cook Inlet

[20] The Middle River segment between RMs 162 and 150 includes an approximately 12-mile-long Class VI rapid known as Devils Canyon. Devils Canyon includes extreme hydraulic conditions with deep plunge pools, drops, and high flow velocities that are difficult to model and pose substantial safety concerns for collecting

at RM 0. Project effects on the Upper River segment upstream of the Watana dam site would not be evaluated by this study. Instead, project effects on aquatic resources within the Upper River segment would be evaluated by numerous other studies described in section 9 of the RSP (e.g., fish distribution and abundance, fish entrainment, fish passage barriers, aquatic habitat mapping). Although both Middle River and Lower River segments would be evaluated as part of this study, the majority of study elements are concentrated within the Middle River segment where flow regulation and load-following operations would have the greatest potential effect on aquatic resources.

Studies in the Lower River during 2013 would focus on two study area locations, one in geomorphic reach LR-1 in the vicinity of Trapper Creek, and one in geomorphic reach LR-2 in the vicinity of Caswell Creek. Each of these study areas includes two tributary mouths that would be modeled. In addition, a fifth tributary mouth, the Deshka River mouth, would be included in the 2013 studies as an important salmon holding location.

In 2013, AEA would apply the mainstem open-water flow routing model to approximately 23.5 miles of the Lower River downstream of the three rivers confluence to RM 75. AEA would use the modeling results to determine whether to include additional instream flow study elements downstream of RM 75. The determination would be based on the following criteria: (1) magnitude of daily stage change due to load-following operations relative to the range of variability for a given location and time under existing conditions (i.e., unregulated flows); (2) magnitude of monthly and seasonal stage change under project operations relative to the range of variability under unregulated flow conditions; (3) changes in surface area (as estimated from relationships derived from LiDAR and comparative evaluations of habitat unit area depicted in aerial digital imagery under different flow conditions) due to project operations; (4) anticipated changes in flow and stage to lower Susitna River off-channel habitats; (5) anticipated project effects resulting from changes in flow, stage, and surface area on habitat use and function, and fish distribution (based on historical and current information concerning fish distribution and use) by geomorphic reaches in the lower Susitna River segment; and (6) initial assessment of potential changes in channel morphology of the lower Susitna River based on project-related changes to hydrology.

AEA proposes to refine the study area selection for the Lower River, review the selections with the TWG by the end of the third quarter of 2013, and finalize the Lower River study areas in the fourth quarter of 2013.

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field data; therefore, AEA does not intend to collect field data or model hydraulic or habitat conditions in Devils Canyon.

AEA proposes the following specific methods to gather the information needed to address the study objectives.

Instream Flow Study Analytical Framework (RSP Section 8.5.4.1)

Develop an instream flow analytical framework designed to integrate riverine processes, including geomorphology, ice processes, water quality, and groundwater-surface water interactions, to quantify changes in indicators used to measure the integrity of aquatic resources. The overall framework includes analytical steps that are consistent with those described in the Instream Flow Incremental Methodology (IFIM) (Stalnaker et al., 1995), which would be used as a guide for completing the instream flow evaluation for the project.

River Stratification and Study Area Selection (RSP Section 8.5.4.2)

As discussed in detail in study 9.9 (aquatic habitat mapping), AEA proposes to stratify the river according to a five-level nested, hierarchical classification scheme. The stratification scheme was applied in selecting study sites for implementing this study.

- Level 1 divides the river into three major hydrologic segments (i.e., Upper River, Middle River, and Lower River segments).
- Level 2 divides the major hydrologic segments into distinct geomorphic reaches (i.e., six geomorphic reaches for the Upper River, eight geomorphic reaches for the Middle River, and six geomorphic reaches for the Lower River).
- Level 3 divides the mainstem into the following categories: main channel, split main channel, braided main channel, side channel, tributary, side slough, upland slough, backwater, and beaver complex.
- Level 4 further divides only the main channel habitats (i.e., main channel, split main channel, and braided main channel) into mesohabitat types (i.e., pool, glide, run, riffle, and rapid).
- Level 5 is a calculation of edge habitat that is made by doubling the length of the mapped habitat unit.

The study areas generally consist of three different approaches for collecting field data to develop models to establish flow-habitat relationships. These include: (1) 88 traditional 1-dimensional cross-sectional transects located primarily in single thread sections of the channel (i.e., 80 located in the Middle River and eight located in the

Lower River); (2) 10 intensive study areas, also known as focus areas,[21] that are located in the Middle River and are sites where 2-dimensional modeling would be conducted; and (3) two study areas and five tributary mouths in the Lower River where 1-dimensional cross-sectional transects would be used to model flow conditions. AEA states that the size and complexity of the Lower River prohibits a 2-dimensional modeling approach similar to that proposed in the Middle River. Instead, AEA proposes a 1-dimensional modeling approach similar to the approach used during the 1980s studies where transects would be selected within major habitat types.

To select specific study sites for each of these three transect types, AEA relied on three different methods that it contends are generally consistent with the methods described in Bovee (1982). These include: (1) representative sites,[22] (2) critical sites,[23] and (3) randomly selected sites.[24]

The 10 Middle River focus areas were finalized in AEA's *Technical Memorandum, Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014, dated March 2013* (herein referred to as the Final Focus Area Tech Memo). Table 1 provides a general description of AEA's proposed focus areas.

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[21] In addition to their applicability to the aquatics Instream Flow Study for conducting 2-dimensional modeling to develop flow-habitat relationships, focus areas are also intended to serve as specific geographic areas of the river that would be the subject of intensive investigation by multiple resource disciplines including riparian instream flow, groundwater, geomorphology, ice processes, water quality, and fish distribution and abundance.

[22] Representative sites are those where professional judgment or numerically and/or qualitatively derived criteria are relied on to select one or more sites/areas that are considered representative of the stratum or larger river. Representative sites typically contain all habitat types of importance.

[23] Critical sites are those where available knowledge indicates that either: (1) a sizable fraction of the target fish population relies on that location, (2) a particular habitat type is highly important biologically, or (3) where a particular habitat type is well known to be influenced by flow changes in a characteristic way.

[24] Randomly located sites are those sites, areas, or measurement locations that are selected randomly from each defined stratum or habitat type, and replicate sites or cross-sections are sampled to estimate variance.

Table 1. Description of Middle River focus areas

Name	Geomorphic Reach and Location (river mile)[a]	Unit Length (mile)
Focus Area 184–Watana Dam	MR-1 (185.7–184.7)	1.0
Focus Area 173–Stephan Lake, Complex Channel	MR-2 (175.4–173.6)	1.8
Focus Area 171–Stephan Lake, Simple Channel	MR-2 (173–171.6)	1.4
Focus Area 151–Portage Creek	MR-5 (152.3–151.8)	0.5
Focus Area 144–Side Channel 21	MR-6 (145.7–144.4)	1.3
Focus Area 141–Indian River	MR-6 (143.4–141.8)	1.6
Focus Area 138–Gold Creek	MR-6 (140.0–138.7)	1.3
Focus Area 128–Skull Creek Complex	MR-6 (129.7–128.1)	1.6
Focus Area 115–Lane Creek	MR-7 (116.5–115.3)	1.2
Focus Area 104–Whiskers Slough	MR-8 (106.0–104.8)	1.2

[a] AEA does not propose any focus areas in geomorphic reaches MR-3 or MR-4 due to safety concerns because of dangerous field conditions within Devils Canyon.

Hydraulic Routing (RSP Section 8.5.4.3)

To analyze the effects of alternative project operating scenarios on aquatic habitat downstream of the dam, AEA proposes to develop an open-water flow routing model. The open-water flow routing model would provide hourly flow and water surface elevation data at numerous locations longitudinally distributed throughout the length of the river extending from RM 184 downstream to RM 75. The results of the initial modeling effort would be evaluated in 2013, and the modeling effort would be extended downstream until a point where project flow fluctuations are within the range of natural variation.

In addition to the open-water flow routing model, AEA also proposes to develop a reservoir operations model to, among other reasons, provide results for many parameters such as simulated reservoir elevation, powerhouse generation, and total reservoir outflow.

Hydrologic Data Analysis (RSP Section 8.5.4.4)

AEA proposes to assess hydrologic data by summarizing seasonal and long-term hydrologic characteristics for the river including daily, monthly, and annual summaries; exceedance summaries; and recurrence intervals of small and large floods. The hydrologic record would rely on the analysis performed by the USGS (Curran, 2012) to develop the synthetic period of record for streamflows for the past 61 years at five mainstem Susitna River locations[25] and at five locations within selected tributaries.[26] The 61-year period of record at these 10 sites would establish baseline hydrologic conditions to assess project effects.

As part of its hydrologic analysis, AEA proposes to utilize the Indicators of Hydrologic Alteration (IHA) and Range of Variability Approach (RVA) developed by the Nature Conservancy (TNC, 2009) for computing baseline hydrologic characteristics. The IHA/RVA models are components of an analytical software package that AEA intends to use as a planning tool to analyze ecosystem response to proposed flow regulation. In RSP section 8.5.4.4.1.3., AEA also notes that other planning tools, such as the U.S. Army Corps of Engineers HEC-EFM program, are available to analyze ecosystem response to changes in flow. AEA proposes to discuss the merits of the various planning tools in collaboration with the TWG during the third quarter of 2013. AEA states that if HEC-EFM is preferable by the TWG, it could be used to assess project effects.

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[25] Susitna River near Denali (RM 291), Susitna River near Cantwell (RM 223), Susitna River at Gold Creek (RM 137), Susitna River at Sunshine (RM 84), and Susitna River at Susitna Station (RM 26).

[26] Maclaren River near Paxson (RM 260), Chulitna River near Talkeetna (RM 98), Talkeetna River near Talkeetna (RM 97), Willow Creek near Willow (RM 48), and Yentna River near Susitna Station (RM 28).

Habitat Suitability Criteria Development (RSP Section 8.5.4.5)

AEA proposes to develop HSC curves[27] for the instream flow modeling effort according to the following steps: (1) selection of target species and life stages, (2) development of draft HSC curves using existing information, (3) collection of site-specific HSC data, (4) development of habitat utilization frequency histograms/preference curves from the collected data, (5) determination of the variability/uncertainty around the HSC curves, and (6) finalization of the HSC curves in collaboration with the TWG.

HSC curves for the project would be based on information consisting of the following (in order of preference): (1) new site-specific data collected for selected target species and life stages (seasonally if possible [e.g., winter]); (2) existing site-specific data collected from the Susitna River during the 1980s studies; (3) site-specific data collected from other similar Alaska river systems; and (4) professional opinion (roundtable or Delphi) of local resource specialists that are familiar with habitat use by the species and life stages of interest for this study.

AEA provides a preliminary list of its proposed target species for HSC development in the RSP and proposes to finalize a draft list of target species and life stages and provide it to the TWG during a meeting to be held in the first quarter of 2013. The final list of species and life stages to be included in the HSC development process would be developed during a subsequent TWG meeting to be held just prior to field activities in the second quarter of 2013.

The field data collection for site-specific HSC development for the 2013 and 2014 study years would be based on a stratified random sampling approach using AEA's proposed hierarchical classification system as well as several other attributes. The proposed number and distribution of 2013 HSC sampling sites would be presented to the TWG during a meeting in the second quarter of 2013. Field data collection methods would include biotelemetry, pedestrian, snorkel, and seining. In addition, two other methods, DIDSON sonar and electrofishing, are being evaluated for their effectiveness in detecting habitat use in turbid water conditions. Selected methods would vary based on habitat characteristics, season, and species/life history of interest.

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[27] HSC curves are typically developed for depth, velocity, substrate, and/or cover and are combined to rate the suitability of discrete areas of a stream for use by a specific fish species and life stage. HSC curves translate hydraulic and channel characteristics into measures of overall habitat suitability in the form of weighted usable area.

For development of site-specific HSC curves, habitat use information (i.e., water depth, velocity, substrate type, upwelling, turbidity, and cover) would be collected at the location of each identified target fish and life stage. AEA's goal is to collect a minimum of 100 habitat use observations for each target species' life stage. However, for data sets with less than 100 observations, bootstrap[28] analysis would be used to develop confidence intervals around each of the data sets used to develop the HSC curves.

AEA proposes to conduct a pilot study during the winter of 2012-2013 at five or six sites in slough and side-channel habitats in the Whiskers Slough and Skull Creek study areas to evaluate the feasibility and effectiveness of studying winter fish use and habitat conditions during the ice-cover period. The pilot study would evaluate the feasibility of using different instruments, methods, and approaches for winter data collection in preparation for a more developed effort during the winter 2013–2014 study period. The 2012–2013 pilot study would also provide preliminary data and information regarding intergravel temperature and water quality conditions, site-specific fish habitat use and behavior, and species richness and size class composition among sampled habitats.

Specific methods for the pilot study include: (1) utilize underwater cameras and DIDSON sonar to record juvenile and adult fish behavior during day and night conditions to identify potential diurnal patterns in habitat utilization during the winter period; (2) obtain measurements of site-specific habitat utilization data for juvenile and adult fish species in support of HSC and HSI development; and (3) develop recommendations for the proposed 2013–2014 winter fish behavior observation studies.

Preliminary results of the 2012-2013 winter pilot study would be distributed to TWG participants by the third quarter of 2013, and proposed methods for the 2013-2014 winter studies would be completed and finalized during the third quarter of 2013.

Habitat-Specific Model Development (RSP Section 8.5.4.6)

AEA's proposed methods for specific instream flow model selection and development include a combination of approaches that vary depending on habitat types and the biological importance of those types, as well as the particular instream flow issue being evaluated.

[28] Bootstrapping is a method for estimating properties of an estimator such as its variance by measuring those properties from an approximate sample distribution. In this case, the sample distribution would be obtained by random sampling with replacement from the original dataset.

Two-dimensional hydraulic modeling would be used to evaluate the detailed hydraulic characteristics of the Susitna River on smaller, localized scales where it is necessary to consider the more complex flow patterns to understand and quantify project effects under various project operating scenarios. Two-dimensional modeling would be applied to specific focus areas that are representative of important habitat conditions and the various channel classification types. AEA proposes to select the sites for 2-dimensional hydraulic modeling in coordination with the TWG to facilitate maximum integration of available information between the instream flow and other studies. Selection of the appropriate 2-dimensional models for use in this study would be coordinated with other pertinent studies and the TWG in first quarter of 2013 and revisited in the first quarter of 2014.

Another model that would be used for evaluating project-related effects on fish habitat is the single-transect 1-dimensional Physical Habitat Simulation Model (PHABSIM) (Milhous et al., 1981). PHABSIM would be applied to some, or all, of the open-water flow routing model transects to develop relationships between main channel flow and habitat for the spawning and rearing life stages of the selected target fish species.

AEA proposes to develop an evaluation framework using results of hourly water surface elevations from the open-water flow routing model to track water-level fluctuations and calculate numerical indices representing the potential for stranding and trapping of aquatic organisms. Indices for predicting stranding and trapping are based on equations that relate physical characteristics of the stranding and trapping areas to the potential for stranding and trapping to occur. The information for the physical site characteristics would be derived from the bathymetry and mapping through the application of GIS. The hourly water-surface elevations would provide the basis for identifying when (and for how long) a stranding or trapping site becomes dewatered or disconnected from the main channel.

An effective spawning/incubation model would be developed based on identifying potential use of discrete channel areas (cells) by spawning salmonids on an hourly basis. Use of each cell by spawning fish would be assumed to occur if the minimum water depth is suitable and velocity and substrate suitability indices are within an acceptable range defined by HSC/HSI. Species-specific HSC/HSI information used to identify potential use of a cell by spawning fish would be developed. If suitable spawning conditions exist, that cell would then be tracked on an hourly time step from the initiating time step through emergence to predict whether eggs and alevin within that cell were subject to interrupted upwelling, dewatering, scour, freezing, or unsuitable water quality.

All of the analyses associated with the effective spawning/incubation model would be performed at each of the focus areas with suitable spawning habitat. The results of the effective spawning/incubation analysis would be a reach-averaged area calculated by weighting the effective spawning area derived for each focus area by the proportion of focus area within the geomorphic reach. The results would be calculated in terms of weighted area (similar to PHABSIM results) and would not represent actual area dimensions. The results cannot be used to calculate numbers of emergent fry but instead provide habitat indicators that would be used to conduct comparative analyses of alternative operating scenarios under various hydrologic conditions.

AEA proposes to conduct a varial zone analysis to quantify the frequency, magnitude, and timing of downramping rates by downramping event by geomorphic reach downstream of the dam. The objectives of the analysis are to quantify reach-averaged downramping events by rate under existing conditions and under alternative operating scenarios for selected hydrologic years. Using the results of the mainstem flow routing models, a post-processing routine would be used to identify those specific hourly time periods when the water surface elevations are decreasing (i.e., downramping). For those time periods, the hourly reduction in water surface elevation would then be computed and expressed in units of inches per hour. A frequency analysis would be conducted on the hourly downramping hours by downramping event by geomorphic reach. The frequency analysis would determine the number of downramping events exceeding selected numeric categories to be selected in collaboration with the TWG.

The frequency, number, and timing of downramping events that occur following varying periods of inundation would be quantified to evaluate the effects of downramping events on organisms exhibiting a range of colonization rates. This varial zone analysis would be conducted by total focus area or can be conducted by discrete habitat types within a focus area (e.g., main channel, side channel, sloughs) using an hourly time step integrated over a specified period that considers antecedent fluctuations in water surface elevations.

Temporal and Spatial Habitat Analyses (RSP Section 8.5.4.7)

A temporal analysis would be conducted and would involve the integration of hydrology, project operations, open-water flow routing model results, and the various habitat-flow response models to project spatially explicit habitat changes over time. Several analytical tools would be utilized for evaluating project effects on a temporal basis. This would include development and completion of habitat-time series that represent habitat amounts resulting from flow conditions occurring over different time steps (e.g., daily, weekly, monthly), as well as separate analyses that address effects of rapidly changing flows (e.g., hourly) on habitat availability and suitability.

A spatial analysis would also be conducted to determine how the data and habitat-flow relationships collected and developed from one location relate to other unmeasured locations. The spatial analysis would feed directly into the integrated resource analysis and would be completed during the 2014 study season after all data are collected and respective models have been developed. Similar to the temporal analysis, the final procedures for completing the spatial analysis would be developed collaboratively with the TWG and with input from other resource disciplines.

The results of the temporal and spatial analyses would include tabular listings of habitat indicator values under existing and alternative flow regimes. Model results would be developed for representative hydrologic conditions and a multi-year, continuous hydrologic record to evaluate annual variations in indicator values. The availability of indicator values over a multi-year record would support sensitivity analyses of the habitat indicators used to evaluate proposed reservoir operations. Sensitivity analyses of individual components of the habitat modeling efforts are a standard technique in model construction, calibration, and assessment and are envisioned as implicit steps in study implementation. Integrating the level of uncertainty in the various model components would provide the TWG with an overall understanding of the robustness of individual habitat indicators. Analysis of habitat indicators over a multi-year record would identify the sensitivity of indicators to hydrologic conditions and the level of certainty associated with decisions regarding alternative instream flow regimes. The design of the sensitivity analyses for habitat indicators would be developed by AEA and reviewed in consultation with the TWG in the fourth quarter of 2013 and implemented in the third and fourth quarters of 2014.

Instream Flow Study Integration (RSP Section 8.5.4.8)

AEA proposes to develop a decision support system to evaluate project effects on Susitna River environmental resources under various alternative operating scenarios. The decision support system would be used to focus attention on those attributes that the TWG believes are highest priority in evaluating the relative desirability of alternative scenarios with respect to natural resources. Evaluation indicators selected for a decision support system type-matrix represent a preliminary analysis to identify the most promising scenarios. When discussion of alternatives focuses on only a few remaining scenarios, those final scenarios would be evaluated using the larger data set of habitat indicators to ensure that environmental effects are consistent with the initial analyses.

Indicator variables would be selected in collaboration with the TWG. The decision support system and supporting software would be initiated in collaboration with the TWG after the initial results of the various habitat modeling efforts are available in

2014. AEA intends to develop the decision support system by early 2015 to assist in evaluating various operating scenarios for completion of the license application.

Comments on the Study

Analytical Framework and Conceptual Ecological Models

EPA, FWS, NMFS, and CSDA request the use of conceptual ecological models, as a tool to frame the likely project effects on ecological function. The commenters support using conceptual ecological models as an outline to the study analysis and study integration and indicate such models are proven tools in environmental impact assessment, ecological risk assessment, ecosystem adaptive planning and management, and environmental mitigation and restoration management. The commenters state that conceptual ecological models are used to identify the essential components of an ecosystem and their functional (e.g., cause-effect) interrelationships. Specifically, the commenters contend that conceptual ecological models: (1) synthesize current understanding of how a system works; (2) help environmental planners and managers understand and diagnose underlying problems; (3) isolate crucial ecosystem components, variables, drivers and constraints, and cause-effect relationships within complex systems; (4) provide a common framework or mental picture that allows stakeholders to more clearly identify and debate issues of concern; (5) provide a tool for making predictions of ecosystem responses to imposed conditions; (6) provide a tool for identifying potential thresholds, from which system responses may accelerate or follow potentially unexpected or divergent paths; (7) provide a framework for identifying crucial monitoring indicators and metrics; (8) identify needs for further research, field monitoring, and computational efforts; (9) supplement numerical models for assessing project benefits and impacts; and (10) provide the foundation for identifying, comparing, and managing adaptive management strategies.

Discussion and Staff Recommendation

The agencies and CSDA provide no specific information on how the recommended conceptual ecological modeling framework would specifically be applied to the instream flow study or the proposed project, nor do they give any consideration to the level of effort and cost (section 5.9(b)(7)) that would be necessary to develop such a model. Further, we are not aware of any instances where a conceptual ecological model was necessary to conduct the required NEPA analysis or develop license requirements (section 5.9(b)(5)). AEA's proposed methodology is consistent with accepted practices within the context of a hydroelectric licensing case (section 5.9(b)(6).

No modifications to the study plan are recommended.

Habitat Classification and River Stratification

NMFS contends that AEA's mesohabitats (i.e., pool, riffle, run, etc.) are subjective classifications that can vary widely based on variations in flow and the person classifying the habitats. NMFS states that AEA's mesohabitat classification implies that each category represents habitat of equal value, and that microhabitat data is needed to identify the differences in hydraulic characteristics between similar mesohabitats. Therefore, NMFS recommends alternative descriptions of habitat classes at all levels, including microhabitat characteristics within each habitat that affect the distribution of fish life stages.

FWS states that the development of HSC curves prior to understanding the habitat utilization by species and life stage of habitat and the criteria that influence that habitat is premature and an inappropriate step at this time. Therefore, FWS requests that a hierarchy of habitat classes be used that includes a description of the microhabitat or characteristics within each habitat that affect the distribution of fish life stages and communities among these habitats.

Discussion and Staff Recommendation

We evaluate the appropriate river stratification and habitat classification system for all aquatic studies, including consideration of microhabitats nested within mesohabitats, in our analysis and recommendations for Study 9.9 (aquatic habitat mapping).

No modifications to the study plan are recommended.

Microhabitat Types, HSC and HSI Development

NMFS requests that the following microhabitat variables be collected: depth, velocity, surface flow and groundwater exchange fluxes, upwelling/downwelling (determined by vertical hydraulic gradient), substrate type, cover, woody debris, turbidity, dissolved oxygen (intragravel and surface water), macronutrients (N, P), temperature (intragravel and surface water), pH, dissolved organic carbon (DOC), alkalinity, invertebrate drift density, benthic organic matter, algal biomass, and Chlorophyll-a.

FWS states that vertical hydraulic gradient, intra-gravel water quality, and groundwater are particularly important microhabitats that are omitted from the assessment and should be included in HSC/HSI development.

EPA states that relationships between the hierarchical habitat classifications proposed by AEA and microscale habitat variables that are statistically relevant to fish use, have not been tested and that the abundance and spatial distribution of microhabitat may not necessarily depend on the spatial distribution of larger-scale aspects of channel planform. EPA suggests that possible spatial relationship(s) between suitable microhabitat conditions (e.g., substrate, depth, velocity, temperature, etc.) and channel planform should be treated as hypotheses that require testing.

Discussion and Staff Recommendation

As noted above, AEA proposes to develop site-specific HSC by collecting microhabitat data for depth, velocity, substrate, proximity to cover (including LWD), upwelling, and turbidity for specific locations where target species and lifestages are observed. Therefore, AEA is already addressing seven of the 18 microhabitat variables recommended by the agencies for detailed analysis and preparation of HSC curves for this study, and its proposed approach for developing HSC curves for these seven variables is consistent with accepted practices for implementing an instream flow study within the context of a hydroelectric licensing case (section 5.9(b)(6)).

In regard to three of the 11 microhabitat variables recommended by the agencies (i.e., invertebrate drift density, benthic organic matter, and algal biomass), HSC would be developed for these resources as part of Study 9.8 (river productivity), in addition to supplementary measures of Chlorophyll-a.

In regard to the remaining eight of the 11 microhabitat variables recommended by the agencies for detailed analysis, there is insufficient information in the project record at this time to make a determination on whether to require AEA to develop preference curves for these eight variables: surface flow and groundwater exchange fluxes, dissolved oxygen (intragravel and surface water), macronutrients (i.e., nitrogren and phosphorus), temperature (intragravel and surface water), pH, dissolved organic carbon, alkalinity, and Chlorophyll-a. Additional information on fish distribution within the project area would need to be obtained and compared to field measurements of these parameters prior to making a determination on whether there is a need to develop preference curves for the various target fish species and lifestages to be included in the instream flow study, as part of the required analysis of project effects (section 5.9(b)(5)). However, we envision that the initial analysis of any potential fish-habitat associations for these parameters would be relatively low-cost (section 5.9(b)(7)) because AEA is already proposing an intensive data collection effort within Middle River focus areas for fish distribution as part of Study 9.6 (middle and lower river fish distribution) and water quality sampling for these parameters as part of Study 5.5 (baseline water quality) and

Study 7.5 (groundwater). Therefore, AEA could conduct the evaluation by relying on the extensive data collection already proposed in the RSP.

We recommend that AEA file with the Initial Study Report, a detailed evaluation of the comparison of fish abundance measures (e.g., number of individuals by species and age class) with specific microhabitat variable measurements where sampling overlaps, to determine whether a relationship between a specific microhabitat variable and fish abundance is evident. We expect the majority of locations where fish sampling and the eight additional microhabitat variable sampling efforts would overlap at a scale where they could be related would occur in focus areas where these sampling efforts are concentrated. If results from these initial comparisons indicate strong relationships may exist between a specific microhabitat parameter and fish abundance for a target species and life stage, expanded sampling may be necessary in 2014 to investigate these microhabitat relationships further. Accordingly, we recommend that AEA include in the evaluation to be filed with the Initial Study Report, any proposals to develop HSC curves for any of the 8 additional parameters as part of the 2014 study season.

Upwelling and Downwelling

NMFS and FWS state that it is unclear how upwelling/downwelling would be identified and implemented for WUA calculations. The agencies recommend that this be determined based on numerical modeling results or direct field measurements (i.e., empirical relationships) specific to each focus area, and not simply recorded as a binomial of upwelling or downwelling

<u>Discussion and Staff Recommendation</u>

AEA proposes to assess upwelling for HSC development based on temperature (FLIR[29], see RSP 5.5 (baseline water quality) and visual clues (e.g., changes in water clarity, visible upwelling); however, it does not appear as though AEA proposes to collect field measurements of vertical hydraulic gradient during its field observations for HSC data collection. There appear to be relatively inexpensive methods (USGS, 2000)[30]

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[29] Forward looking infrared (FLIR).

[30] According to USGS (2000), vertical hydraulic gradient can be measured by inserting a metal standpipe (e.g., metal pipe with a band of perforations near a pointed tip) into the stream bed to a depth of about 20–40 cm; inserting clear plastic tubing into the standpipe with one end near the perforations and the other open to the air; filling the tubing with water; and then measuring the difference in water level between the clear tubing and open-water surface near the standpipe.

for conducting empirical (field) evaluations of vertical hydraulic gradient during HSC observations (section 5.9(b)(7)) that would likely be more accurate than simply looking at water clarity and trying to identify visible upwelling (section 5.9(b)(6)).

We recommend that AEA test the feasibility of measuring vertical hydraulic gradient as a site-specific microhabitat variable using field measurements, and if determined feasible and effective at describing upwelling, incorporate the methods into the site-specific HSC development process. The results of the feasibility test (regardless of whether a feasible or infeasible finding is made) should be summarized in the Initial Study Report.

Use of 1980s Studies for HSC Curves

NMFS requests that any criteria developed from 1980s studies on the Susitna River include all likely factors that influence the utilization of habitat characteristics the curves are used to assess, including water quality (i.e., dissolved oxygen, turbidity, and temperature), habitat spatial structure (i.e., distance to cover, large wood, bank and bedform characterization), and groundwater upwelling or downwelling in addition to the typical hydraulic variables (i.e., flow, depth, substrate).

<u>Discussion and Staff Recommendation</u>

AEA notes in the RSP that its preference, prior to using any existing data, would be to develop HSC curves by collecting up to 100 observations of each target species' life stage during the 2013 and 2014 study seasons. It would therefore be premature to evaluate the applicability of the 1980s HSC data collection efforts, prior to knowing whether any of the 1980s HSC curves would actually be used for the study. There would be additional opportunities during prefiling study implementation to evaluate the applicability of any existing 1980s HSC curves, should AEA fail to meet its targets for site-specific observations.

No modifications to the study plan are recommended.

Site-specific HSC and HSI Development and Locations of HSC/HSI Sampling

NMFS and FWS request that only site-specific HSC/HSI be used in assessing instream flow effects on fish from project operations because criteria from other sites (in Alaska or other places) presents a large risk of misrepresenting project effects on fish and their habitat.

NMFS requests that either HSC/HSI sampling be conducted in focus areas or additional habitat variables need to be measured at HSC/HSI sampling locations to capture the full range of microhabitat variables that likely influence habitat utilization.

FWS requests that HSC/HSI study area selection include areas within each of the macrohabitats used by each species and lifestage. The selection should include enough replication in each of the macrohabitats for each of the relevant mesohabitats so that mesohabitats can be statistically compared among different macrohabitats.

FWS states that in the development of HSC curves it should not be assumed that mesohabitats in different macrohabitats are the same, as there may be unique conditions that dictate the utilization of the specific habitat. NMFS requests sampling replicate macrohabitats to avoid psuedoreplication.

FWS requests that further details on the application of the "bootstrapping" analysis be provided to demonstrate the validity of its application.

Discussion and Staff Recommendations

AEA's proposed approach of first attempting to collect up to 100 observations of each target species' life stage using a stratified random sampling design, prior to relying on existing curves, is both consistent with generally accepted practices in the scientific community (section 5.9(b)(6)), and should provide a robust data set to develop the aquatic habitat models and evaluate project effects (section 5.9(b)(5)).

In regard to the "bootstrapping" analysis, we find the proposed approach is consistent with generally accepted practices in the scientific community for assessing variance and generating confidence intervals around a curve (i.e., HSC) developed from a distribution of point measurements (section 5.9(b)(6)).

No modifications to the study plan are recommended.

Water Quality Monitoring at Salmon Spawning Locations

FWS requests that intergravel temperature, dissolved oxygen, and water level monitoring be expanded to include spawning locations for all five Pacific salmon species that were observed in mainstem habitats in 2012 (not only chum and sockeye salmon, as proposed).

Discussion and Staff Recommendation

Expanding the monitoring effort for select spawning locations within focus areas would be consistent with the intent of focus areas, and would provide useful species-specific information to evaluate project effects, especially given that the proposed project would likely affect spawning habitat within mainstem habitats for all five species of Pacific salmon (section 5.9(b)(5)).

We recommend that AEA monitor temperature, dissolved oxygen, and water level monitoring data at one or more select Chinook, pink, and coho spawning locations within Middle River focus areas.

Instream Flow Study Areas and Study Sites

FWS states that the proposed focus areas are not representative of the actual habitats of the Susitna River, and that AEA's classification system is not structured appropriately to characterize the site-specific conditions of macro, meso, and microhabitat types by all fish species and life stages.

NMFS and FWS request that a sufficient number of sites be sampled in the Middle River and Lower River to study the riverine processes in detail and to represent the biological use of habitats. NMFS is concerned that the locations and numbers of focus areas may not be adequate to determine fish distribution and identify the variables within macrohabitats that define fish habitat associations.

NMFS and FWS state that, in general, the current focus areas are clumped within the upper portion of the Middle River, above most (approximately 90%) of the currently documented salmon spawning areas, and within more confined geomorphic reaches with less channel complexity. FWS believes the current proposed focus area locations would not contain sites that can be used to adequately identify fish habitat relationships and fish distribution within the Middle River. NMFS and FWS recommend correcting this by shifting focus areas from MR-2 and the upper end of MR-6, into MR-7 and further downstream in MR-6. NMFS and FWS also recommend adding an additional focus area in MR-8. TNC supports NMFS' and FWS' request to move some of the focus areas downstream and add one within MR-8.

Specifically, NMFS and FWS request the following modifications to the selection of focus area locations: (1) move focus area 171 in MR-2 to a site within MR-6 that includes 4th of July Creek and the sloughs upstream; (2) move focus area 151 in MR-5 to a site in MR-7, possibly near Lower McKenzie Creek or below Curry Station on Old Oxbow II; and (3) add a focus area to MR-8 downstream of Whiskers Creek but upstream from the Chulitna River confluence. NMFS and FWS state that the two focus areas in MR-2 and the upper three focus areas in MR-6, collectively 50% of the sites and focused effort, is clumped within less than eight river miles of the approximately 85-mile-long Middle River reach. The agencies state that three focus areas (or 30%) are located above Devils Canyon and upstream of most adult spawning (~90%) and therefore are not representative of sites accessible to most juvenile salmon. NMFS and FWS state that the three focus areas above Devils Canyon are within fairly uniform reaches and do not represent those areas with most channel complexity and fish habitat, and that have the greater potential to be modified by the proposed project.

NMFS and FWS state that current focus areas may be representative hydrologically, but biologically several areas in MR- 6 are located near major spawning areas and may reflect an abundance of spawning habitat and not be representative of juvenile fish rearing habitat. The agencies note that, if fish densities are high because of proximity to spawning sites and tributaries, then fish may occupy less than preferred or marginal habitats, not by choice but by circumstance. The agencies state that two of the five focus areas located downstream of Devils Canyon, focus area 151 at Portage Creek and focus area 141 at Indian River, accounted for more than 50% of the total juvenile Chinook salmon catch in the 1980s and therefore would more likely be categorized as critical sites (not representative sites). The agencies also state that three of the four remaining focus areas in MR-6, focus area 144 at Slough 21, focus area 139 at Slough 9, and focus area 128 at Slough 8A contain the majority of currently documented sockeye salmon spawning. Therefore, the agencies state that, by definition, many of the focus areas would be considered critical sites and not representative.

FWS does not support a proposal to adjust focus area locations after 2013 studies. FWS states that moving a focus area in 2014 would reduce site-specific sample size for annual comparisons within specific sites and would further limit the ability to evaluate overall annual variability, particularly because these sites were not selected randomly.

TCCI requests that sites be added at Portage Creek and Lane Creek because these tributaries represent locations with documented fish production.

NMFS requests that critical sites be identified when fish studies are completed, including juvenile fish studies.

FWS recommends completing the Upper River and Lower River habitat identification and mapping in order to select representative sites.

Discussion and Staff Recommendation

AEA states that focus areas were selected during an AEA internal multidisciplinary meeting with study leads from various biological and physical process studies, and the locations were chosen in areas that it deemed representative of the major features in each of the geomorphic reaches. Specifically, AEA states that focus areas were selected to include: (1) mainstem habitat types of known biological significance (i.e., where fish have been observed based on previous and/or contemporary studies); (2) locations where previous sampling revealed few or no fish (i.e., focus area 141 at Slough 17); and (3) representative side channels, side sloughs, upland sloughs, and tributary mouths.

AEA's approach to select a minimum of one focus area within each geomorphic reach is consistent with the intent of their habitat classification system and sampling framework, and should facilitate the meaningful extrapolation of results. This is common practice when stratifying based on physical characteristics and processes, and is appropriate for evaluating aquatic resources over broad spatial scales (section 5.9(b)(6)).

NMFS' and FWS' statements that channels in the upper reaches are less complex and have less fish rearing habitat may be accurate; however, this does not justify abandoning the habitat classification system (which is similar to the classification system proposed by NMFS and FWS) and sampling framework. Moving focus area 151, as recommended by NMFS and FWS, would eliminate the only focus area in reach MR-5, and would be inconsistent with the overall sampling approach. In addition, focus areas are intended to be sites where intensive interdisciplinary studies are proposed, and therefore, require broader consideration than salmon production alone.

NMFS' and FWS' comments that focus areas are clumped in the upper reaches is primarily a function of geomorphic reach length. If corrected for length, reaches MR-6 and MR-8 have greater representation within focus areas compared with reaches MR-2 and MR-5. MR-1 is a relatively short 2-mile-long geomorphic reach, and therefore, the focus area in this reach would make up a large proportion of the reach (50%).

NMFS' and FWS' requests to move focus area 171 from MR-2 to a location within MR-6 that includes 4th of July Creek and the sloughs upstream, would result in a more disproportionate level of reach MR-6 within focus areas as compared with other reaches. However, we note that with AEA's proposed focus areas, reach MR-7 has the lowest proportional length within the focus area (approximately 8%). Moving focus area 171 from MR-2 to a site in MR-7, possibly near Lower McKenzie Creek or below Curry on old Oxbow II as NMFS and FWS recommend, would retain relatively proportional lengths of reaches in focus areas. Moving focus area 171 from MR-2 to MR-7 would result in reaches MR-6, MR-7, and MR-8 having the greatest proportion of the reach length in focus areas (ranging from approximately 17–22% by length) compared with MR-2 and MR-5 (12% and 10%, respectively). This is consistent with the agencies' request that sampling be weighted toward lower reaches (MR-6–MR-8) where Middle

River spawning and rearing is likely greatest. AEA states that they would not oppose relocating a focus area in MR-2 to MR-7 prior to the initiation of the 2013 field studies, provided there is sufficient justification for such relocation, and the resulting focus area remains representative of other areas in the Middle River.

AEA proposes one focus area in geomorphic reach MR-8 (focus area 104) that includes Whiskers Slough and comprises approximately 22% of the reach length. Focus area 104 and the agencies' recommended location downstream of Whiskers Creek are both immediately upstream of the Chulitna River confluence and likely strongly influenced by the hydrology of the Chulitna River. Characterizing conditions in this area and developing an understanding of the physical processes and dynamics of the lower Chulitna River and the confluence with the Susitna River would likely require substantial effort and cost (section 5.9(b)(7)) and would be difficult to model with a reasonable degree of precision and confidence. AEA's proposed focus area 104 would comprise 22% of reach MR-8, a relatively high level of subsampling. For these reasons, there would be few additional benefits to justify the likely high cost of implementing an additional focus area within MR-8 downstream of Whiskers Creek.

AEA proposes focus areas at both Portage Creek (focus area 151 in MR-5) and Lane Creek (focus area 115 in MR-7) which addresses TCCI's request that sites be added in these locations.

We recommend that AEA: (1) consult with the TWG and select an appropriate focus area within MR-2 to eliminate from the study; (2) consult with the TWG and establish an additional focus area in geomorphic reach MR-7 that is sufficient for conducting interdisciplinary studies, possibly near Lower McKenzie Creek or below Curry on old Oxbow II; and (3) file a detailed description of the changes to the proposed focus area locations in MR-2 and MR-7 by May 31, 2013, and include in the filing documentation of consultation with NMFS, FWS, and Alaska DFG, including how the agency comments were addressed.

Hydrologic Assessment and Environmental Flow Methods

NMFS supports the use of IHA/EFC to analyze the existing flow regime and to attempt to identify ecological important flow statistics. NMFS requests that this analysis be compared with an alternative operation scenario statistical analysis at not only existing stream gages (e.g., Susitna River at Gold Creek, Susitna River near Sunshine) but also at ecologically significant reaches in the Middle River and Lower River. NMFS states that the open period and winter hydraulic flow routing models should be used to develop baseline and alternative operating scenario periods of record for stage and flow, and then the IHA/EFC analysis should be conducted to produce relevant statistics for comparison.

NMFS requests that the hydrologic period of record for the project include data from the years of study (i.e., 2013–2015) and that hydrologic conditions for the years of study should be compared to the total period of record to characterize the representativeness of the years of study with regard to hydrology.

FWS requests the characterization of biological cues that are flow dependent to provide an understanding of how the project-hydrology alterations demonstrate effects to existing biological resources.

Discussion and Staff Recommendation

AEA's proposal to use the IHA/RVA models to evaluate project effects on the natural flow regime and corresponding effects on ecological processes is a commonly applied method for evaluating alternative operating scenarios for a regulated flow regime (e.g., Olden and Poff, 2003). Although some elements of the hydrologic assessment are not included in the RSP, AEA proposes to develop these through a meeting with the TWG during the third quarter of 2013. And, in any event, there is sufficient information provided in the RSP to conclude that AEA's proposed approach and level of effort is consistent with other hydrologic modeling efforts used to run the IHA/RVA models and should be adequate to describe the existing environment and evaluate project effects on the natural hydrograph and associated environmental flow components (section 5.9(b)(5)).

In regard to the appropriate period of record for the IHA/RVA analysis, AEA proposes to use a 61-year period of record which is sufficient for this type of analysis. We therefore see few benefits in requiring AEA to utilize flow data from the 2013-2015 study years, as this would result in a delay in conducting the analysis and would not likely result in a substantially different or better outcome (section 5.9(b)(6)).

In regard to an assessment of biological flow cues, AEA already proposes to conduct an analysis of flow-dependent biological cues to better understand possible relationships between climatic, hydrologic, and fish habitat indices and salmon abundance and migration timing. The assessment would be based on available long-term datasets for Deshka River Chinook salmon and Yentna River sockeye salmon, and any other Susitna River basin long-term data sets pertaining to salmon migration timing and abundance that are available. This is a reasonable approach that appears to address FWS' requested analysis and should provide sufficient information to evaluate project effects (section 5.9(b)(5)).

No modifications to the study plan are recommended.

Habitat Models and Modeling

FWS expresses concern that the use of PHABSIM has limited utility and application in that it would not account for fundamental habitat variables that fish key in on related to habitat site selection and it would not necessarily address all the microhabitat variables of concern to the FWS. FWS states that the spatial arrangement and connectivity of meso and micro habitat can be better represented by using a two-dimensional model.

NMFS requests that breaklines be surveyed to develop digital elevation models (DEMs) anywhere two-dimensional models would be utilized.

NMFS requests that FERC define the formal process to resolve differences in opinion as to which models or HSI/HSC are to be used.

Discussion and Staff Recommendation

We address FWS' concerns about the appropriate microhabitat variables to be used in the instream flow study in our analysis and recommendations for *Microhabitat Types, HSC and HSI Development*.

PHABSIM, including its use of HSC/HSI, is a proven and accepted approach for evaluating changes to fish habitat relationships at the microhabitat scale (section 5.9(b)(6)).

Both one-dimensional and two-dimensional modeling approaches are consistent with accepted practices for implementing an instream flow study using PHABSIM (section 5.9(b)(6)). We note, however, that AEA does not identify in the RSP the specific locations where one-dimensional versus two-dimensional modeling would be applied, except for noting that two-dimensional modeling would be applied within some focus areas. NMFS is concerned that there may be disagreements about the selection of the appropriate habitat-specific models and the specific locations where one-dimensional and two-dimensional modeling would be applied. In our analysis and recommendations for Study 6.6 (geomorphology modeling), we are recommending that AEA file by the end of the second quarter of 2013, its proposed technical memorandum that summarizes the specific models and locations where one-dimensional and two-dimensional modeling would be applied pursuant to Study 8.5 and Study 6.6.

AEA proposes to use a combination of methods to develop topographic surfaces for two-dimensional habitat modeling in focus areas. LiDAR would be used for the upper portions of the channels and overbank or floodplain areas, bathymetry would be used at locations deep enough for a fathometer (a type of echo-sounder used to measure depth), and Real Time Kinematics GPS or total station surveys would be used for remaining locations. This is a standard and acceptable scientific approach in this setting (section 5.9(b)(6)). Surveying breaklines as requested by NMFS appears to be addressed by AEA (see RSP 6.6.4.1.2.9.2) and is a preferred practice where feasible, particularly where Real Time Kinematics GPS or total station surveying would be used.

No modifications to the study plan are recommended.

Lower River Studies

NMFS and FWS recommend that the winter flow-routing model be included in the determination of the downstream effects of the project operation as the operations proposed in winter time (including the proposed load-following operations) would likely extend into the Lower River.

TNC requests that geomorphology, instream flow, and ice process studies include the Lower River. CWA supports Lower River studies and states that it is unclear whether the Lower River below the Yenta River confluence would be included in studies.

Discussion and Staff Recommendation

AEA does not explicitly state that the winter flow-routing model would be used to assess the downstream extent of project effects; however, we expect that all available information in the project record (as initially described in the initial and updated study reports), including the winter flow-routing model results, would be evaluated and used to determine the appropriate downstream extent of project effects.

As described in the Final Focus Area Tech Memo filed on March 1, 2013, AEA proposes to implement study components related to Study 8.5 (fish and aquatics instream flow), Study 8.6 (riparian instream flows), Study 7.5 (groundwater), Study 9.6 (middle and lower river fish distribution), Study 6.5 (geomorphology), Study 7.6 (ice processes), and Study 5.5 (baseline water quality) in the Lower River study area in 2013 and 2014. We therefore see no inconsistencies between AEA's proposed Lower River studies and TNC's Lower River study requests.

AEA proposes to extend the open-water flow routing model to a location downstream of the Yentna River in 2013. AEA also proposes to add two reaches for winter HEC-RAS modeling to estimate the pre-and post-project maximum increase in winter stages, one downstream of the Sunshine Bridge (between PRM 80 and PRM 85), and a second downstream of the Yentna River confluence (from PRM 28 to PRM 32).

AEA's proposed Lower River study approach is a reasonable initial level of effort (section 5.9(b)(7)) to evaluate potential project effects on instream flow and aquatic habitat in the Lower River segment. Should the study results or any other available information, as documented in the initial and updated study reports, indicate that project effects are of a greater magnitude or extend further downstream than anticipated, additional study sites could be proposed or requested in subsequent years.

No modifications to the study plan are recommended.

Winter Studies

FWS recommends inclusion of detailed implementation plans on the sampling design specifics for fundamental winter habitat use.

NMFS and FWS recommend that winter discharge measurements be taken frequently enough to characterize the variation of flow during winter at enough cross-sections in each of the geomorphic reaches to characterize the changing flow conditions with changes in ice and flow conditions throughout several winters.

NMFS requests that winter fish sampling, particularly for overwintering juvenile salmon, occur at a minimum of six replicate tributary mouths, main channel or side channel backwaters, side sloughs, and upland slough habitats.

Discussion and Staff Recommendation

AEA's proposed initial study efforts for characterizing aquatic habitat during the winter are limited to a pilot study to be implemented in the winter of 2013 to test the feasibility of various sampling strategies and assess the importance of areas of upwelling to fish use during the winter. Any additional winter study efforts would be determined in the fall of 2013 in consultation with the TWG based on the results of the pilot study. Due to the challenging and potentially dangerous field conditions that are present in the Susitna River Basin during the winter, AEA's phased approach, beginning with a pilot study, is a reasonable initial level of effort in the circumstances of this case (section 5.9(b)(7)). The proposed pilot study sampling methods appear to be consistent with scientifically accepted practices for winter sampling under ice conditions (section 5.9(b)(6)) and should be sufficient to make an informed decision on the level of effort for future winter studies. There would be additional opportunities throughout ILP prefilling study implementation to evaluate the effectiveness of winter sampling methods and, if found to be effective, apply additional winter sampling efforts throughout the study area. These include the summary of results of the 2012–2013 pilot winter study and proposed methods and sites for the 2013–2014 winter studies in the fall of 2013 as proposed by

AEA, and in response to information contained in the Initial and Updated Study Reports (sections 5.15(c)(2) and 5.15(c)(4)).

No modifications to the study plan are recommended.

Riparian Instream Flow Study (8.6)

Applicant's Proposed Study

AEA proposes to study the relationships between recruitment and growth of riparian vegetation and Susitna River flow, sediment, and ice process regimes to determine the potential effects of project operation on downstream riparian vegetation (e.g., vegetation establishment, species composition, channel encroachment, maintenance, and succession). First, existing Susitna River groundwater and surface water flow, sediment, and ice process regimes would be measured and modeled relative to floodplain plant community establishment, recruitment, and maintenance requirements. Second, predictive models would be developed to assess potential project operational impacts to floodplain plant communities. Finally, the results of the predictive models would be applied spatially in a Geographic Information System (GIS) to the riparian vegetation map produced by the Riparian Botanical Survey Study to produce a series of maps of predicted changes under alternative operational flow scenarios.

The study area is divided into the Middle (RM 98.5 to 184) and Lower River (RM 30 to 98.5). Riparian community relationships within the Middle River would be intensively studied by sampling within five focus areas and an as-yet undetermined number of satellite sites to sample underrepresented vegetation types and habitats.[31] Within the Lower River, riparian community relationships would be studied by sampling along five transects selected to sample communities associated with specific geomorphic reach types.

To accomplish study goals, AEA would:

1) Synthesize relevant existing physical and biological data related to Susitna River floodplain vegetation.

[31] To capture the variability in floodplain vegetation types, and geomorphic terrains within each riparian process domain not found within the focus areas, satellite study sites would be surveyed outside focus areas using the Integrated Terrain Unit riparian vegetation sampling protocols detailed in Study 11.9 (riparian vegetation), section 11.6.4.

2) Delineate sections of the Susitna River with similar environments, vegetation, and riparian processes (termed riparian process domains),[32] and select representative areas within each riparian process domain (termed focus areas), for use in detailed physical process and vegetation surveys and sampling. Study sites would be selected in coordination with the riparian habitat, groundwater, aquatic instream flow, fluvial geomorphology, geomorphology, and ice processes studies.

3) Characterize the groundwater and surface water hydroregime requirements of seed dispersal and seedling establishment for several dominant riparian woody species. This would be accomplished by: measuring cottonwood and select willow species seed dispersal timing; developing a degree-day model for the onset of seed release using continuous temperature measurements from meteorological stations; and developing a model that predicts cottonwood and willow seedling establishment based on the overlap of seed dispersal timing and key components of the river hydrograph.

4) Characterize the role of river ice in the establishment and recruitment of dominant floodplain vegetation, and develop a predictive model of the proposed project's potential operational impacts on ice processes and dominant floodplain vegetation establishment and recruitment. This would be accomplished by mapping tree ice-scars and ice-related soil disturbance throughout the study area, and interviewing local Susitna River residents about historic ice dam locations and ice process effects. This information would be used to map areas with varying levels of ice process-related effects on vegetation. The ice process map would be used to: (1) delineate riparian process domains and (2) develop a floodplain vegetation study to compare floodplains affected by ice with those unaffected by ice, similar to the approach of Engstrom et al. (2011). The methods for the comparative study would be refined in the second quarter and third quarter of 2013 as tree ice-scar field data become available and ice effect domains are delineated. The comparative study results would be combined with the results of Study 7.6 (ice processes) to develop an integrated model of ice process interactions with floodplain vegetation.

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[32] Process domains define specific geographic areas in which various geomorphic processes govern habitat attributes and dynamics.

5) Characterize the role of erosion and sediment deposition in the formation of floodplain surfaces, soils, and vegetation, and develop a predictive model of the proposed project's potential operational changes to erosion and sediment deposition patterns and associated floodplain vegetation. This would be accomplished by: sampling floodplain soils from the surface to the historic channel bed and measuring soil stratigraphy in focus areas; conducting standard sediment grain size sieve analysis of the entire sediment profile; direct dating of fluvial sediments using isotopic techniques; and using dendrochronologic techniques to age trees and current floodplain surfaces at each soil pit.

6) Characterize the natural floodplain vegetation groundwater and surface water maintenance hydroregime, and develop a predictive model of the proposed project's potential changes to the natural hydroregime and potential floodplain vegetation. This would be accomplished by: using information from Study 7.5 (groundwater) and Study 11.6 (riparian vegetation; determining woody species' sources of water from stable isotope analyses of groundwater, soil water, precipitation, and xylem water hydrogen and oxygen; measuring the rooting depth of dominant floodplain plants through excavation of trenches in each focus area plant community type; conducting a riverbank survey by boat to measure recently exposed root systems; summarizing individual plant species and plant community type root zone depth statistics; and modeling the response of riparian plant communities to alterations in surface water and groundwater regimes.

7) Use spatially explicit GIS-based models to scale-up the study results and modeling from focus areas to riparian process domains. The scaled-up modeling would then be used to assess the proposed project's potential operational flows on downstream processes and riparian vegetation.

Comments on the Study

Study Plan Integration and Interdependency

NMFS and FWS are concerned that the final, approved study would be fragmented and scattered among several documents, and would lack sufficient detail to capture the changes between the revised study plan filed on December 14, 2012 and the information filed in the March 1, 2013 Technical Memorandum. Both agencies recommend that all changes be consolidated into a comprehensive and integrated study plan, to reduce the likelihood of omissions and misunderstandings, and that the agencies be afforded an opportunity to review the changes before FERC approval.

FWS also requests that, in addition to the objective of evaluating sediment deposition on establishment and recruitment of riparian vegetation (objective #5 above), AEA evaluate project-induced changes on channel width, migration, and bed elevation because these changes can influence the river stage and location of the surface-water boundary, which in turn can affect the groundwater model used to predict riparian plant community responses to the project.

Discussion and Staff Recommendation

Consolidating the various changes in the RSP would help stakeholders and field crews track the various changes, but it would not substantively change the study. Study reports are required to document the methods used and any deviations from the study plan. Thus, the reports would provide a consolidated description of the study methods sought by the agencies.

The suggested fluvial geomorphic conditions (channel width, migration, and bed elevation) would be evaluated in the geomorphology study. As illustrated in figure 8.6-1 (Study interdependencies for Riparian Instream Flow Study) of the RSP, AEA intends to incorporate this information into its assessment of project effects on riparian vegetation.

No modifications to the study plan are recommended.

Study Area

NMFS and FWS concur with the current downstream extent of the riparian study area to PRM 29.5.[33] However, they state that if information gathered in 2013 and 2014 suggest project effects extend further downstream, they expect AEA to sample further downstream to address potential effects on estuarine wetlands. NMFS and FWS also state that they are still unsure how the lateral extent of the floodplain has been defined. NMFS and FWS recommend that AEA define, in collaboration with the technical working groups, "the lateral extent of the floodplain boundary to include a combination of surface-water flooding, groundwater potentially influenced by project operation, and current riparian communities."

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[33] River Mile (RM) is the length used in the RSP (and is consistent with river miles as identified in the license proceeding for FERC no. 7114). Project River Mile (PRM) is an updated and more accurate assessment of river miles and is used in filings supplementing the RSP. The updated river miles are based on the digitized wetted width centerline of the main channel from 2012 Matanuska-Susitna Borough digital orthophotos.

Discussion and Staff Recommendation

As discussed above under general comments, the need for additional sampling effort in the Lower River would be based on a number of factors that would not be known until after the first-year studies have been completed, and the agencies will have an opportunity to request expanding the study area based on 2013 and 2014 study results.

Section 8.6.2 defines the study area as "the Susitna River active floodplain that would be affected by the operation of the Project downstream of Watana Dam. The active floodplain is the valley bottom flooded under the current climate." In its response to comments on the revised study plan, AEA clarified that the lateral extent of the riparian study area would be the 100-year floodplain because this width would encompass the area in which groundwater could be affected by project operation.

The lateral extent of the study area as depicted in various meetings and in Study 11.6 (riparian vegetation study) appears to include the entire alluvial valley floor. This seems a reasonable approximation of the zone in which groundwater is most likely to be influenced by project operational changes in surface and groundwater. The groundwater study would help further refine the area of project influence. It also includes those areas of the valley bottom directly influenced by regular (0-25 year) to irregular (25-100 year) overbank flooding, which typically define riverine physiography. Thus, AEA's study is consistent with accepted methods (section 5.9(b)(6)), and should provide information necessary to support the design of the project, assess environmental effects, and help inform the development of license requirements (section 5.9(b)(5). The agencies would have an opportunity to request expanding the study area based on 2013 and 2014 study results.

No modifications to the study are recommended.

Herbaceous Community Sampling and Final Selection of Focus Areas and Sampling Sites

NMFS and FWS consider herbaceous plant communities to be just as important as woody communities for fish and wildlife habitat. Because sufficient information exists to map herbaceous communities in most of riparian process domain 4, NMFS and FWS recommend that this information be provided for stakeholder consideration before the riparian process domain 4 focus areas are finalized.

NMFS and FWS also recognize that all plant communities cannot be represented within a riparian process domain due to the irregular distribution of plant communities in the river valley, and they say that they concur with AEA's approach to sample underrepresented or missing plant communities in "satellite areas." Both agencies recommend that AEA sample the satellite areas with the same level of intensity as the focus areas for the target plant communities, including sampling the parameters required to meet the objectives established for the focus areas and to develop proposed predictive models. These parameters would include continuous surface and groundwater level monitoring during the growing season, as well as the same accuracy and extent for land surface elevation. Because the technical working group has not finished discussing satellite areas to address missing information, the agencies recommend AEA consider establishing a transect at PRM 185.2 (site likely affected by sediment loss and before first sediment input below the dam), PRM 182.9 (site likely affected by sediment loss and below first sediment input), PRM 133.3 (site representing open conifer forest missing in focus areas 7,8, and 9), PRM 111 to 115 on river right (herbaceous communities underrepresented or missing in many other focus areas), and the distributary channel[34] that branches off from the west side of the Susitna River between PRM 104.1 and 104.7 (this appears to represent a unique feature likely affected by project operation).

Discussion and Staff Recommendation

AEA's habitat mapping and statistical analysis from its 2012 studies indicates that the variability of the process domains and vegetative community types are generally captured within the boundaries of the geomorphic reaches and can be sufficiently characterized within 5 focus areas.[35] The results of the analysis did not show the need to add any supplemental sites or focus areas in the Middle River segment. Nonetheless, AEA proposes to complete a "quantitative determination" prior to summer field operations to select additional vegetation sample sites (i.e., satellite sites), throughout each of the three Middle River process domains to be representative of herbaceous plant communities.

As AEA states in their *Focus Area and Study Site Selection Technical Memorandum*, the methods described in Study 11.6 (riparian vegetation) would be used in satellite areas. While these methods are not as intensive as those proposed for Focus Areas, these methods include the measurement of vegetation composition, vegetation structure, depth to groundwater, and other parameters that would enable the development of vegetation-flow response curves using the methods of Henszey et al. (2004), as proposed. Thus, AEA's study is consistent with accepted methods (section 5.9(b)(6)),

[34] A distributary is a branch of a river that flows away from the main stream.

[35] See Table 15 of AEA's technical memorandum for final selection of focus areas for the riparian instream flow study.

and should provide information necessary to support the design of the project, assess environmental effects, and help inform the development of license requirements (section 5.9(b)(5).

Therefore, no modification to the study plan is recommended.

Seed Dispersal

NMFS and FWS assert that Figure 8.6-8 suggests that no seed dispersal sites would be established in the middle reach. They recommend that an additional seed dispersal study site be added between the proposed sites in the lower and upper reaches to represent the area most likely to be subject to flow fluctuation effects and a transitional zone between a lower elevation coastal climate and a higher elevation interior climate. They suggest that with the addition of this site, a comparison could be made be to evaluate the potential effects of a warming climate on seed dispersal.

Discussion and Staff Recommendation

Four seed dispersal study sites have been selected, one of which occurs on the boundary of the upper and middle reach and another which occurs on the boundary of the middle and lower reach. The other two sites are above and below these two boundary sites, respectively. The spatial distribution of these sites should be sufficient to detect the range of climate conditions in the project area that are relevant to the timing of seed release. Because the project would not likely influence regional climate, the study of climate warming on seed dispersal is not necessary to evaluate the project's potential effects on riparian vegetation.

No modification to the study plan is recommended.

Seedling Establishment

FWS recommends that AEA sample seedling establishment after each bimodal peak flow, not just once annually in September as proposed. FWS asserts that this information is needed to understand the timing and importance of the peak flows in seed dispersal and establishment because it is not entirely known which peak is synchronized with the dominant woody tree seed release period, and the influence that a second peak flow has on seed germination and seedling survival.

AEA asserts that this information is not necessary to assess overall project effects. AEA believes that using woody seedling dendrochronology to date the year of seedling establishment and relating that establishment to the hydrologic record would provide adequate means to model “recruitment flow regime.”

FWS believes that following a cohort of second-peak germinated plants would likely be more sensitive than aging woody seedlings and attempting to relate their survival to past bimodal peaks. FWS also asserts that aging woody seedlings is likely more appropriate for mature plants where past flow regimes are the only option for estimating recruitment and not establishment.

Although not part of the study plan, AEA would conduct a three-year second-peak seedling cohort establishment and survival analysis to inform the adaptive management of future instream flow options. The results of this three-year study would not be available prior to filing the license application. FWS asserts that this information is relevant now to understand project effects and develop the license application.

Discussion and Staff Recommendation

AEA proposes to count and measure the heights of seedlings in early September. The hydrographs in the PAD illustrate a high flow period between approximately May through September. During this period, there can be several peak events, with the largest typically in June. Determining when the peak has occurred, or as FWS might be suggesting, sampling after each peak event could be problematic and would be costly (at a minimum doubling the cost of the effort).

Project operation as proposed would reduce peak flows. Understanding how this affects seedling establishment and recruitment and how project operations might be modified to minimize such effects (e.g., timing and magnitude of flows to promote seedling establishment) is one of the goals of this study which cannot be fulfilled following AEA's methods alone. For this reason and the reasons given by FWS, we recommend that the study plan be modified to require AEA to sample seedling establishment following the initial spring peak flows (e.g., July) and again in September in 2013 and 2014. This is consistent with accepted methods (section 5.9(b)(6)), and would provide information necessary to support the design of the project, assess environmental effects, and evaluate proposed environmental measures.

Adequacy of MODFLOW and Xylem Water Isotopic Sampling to Establish Groundwater/Hydroperiod Relationships

FWS continues to question the resolution and, therefore, adequacy of the proposed groundwater model MODFLOW to quantify hydroperiod relationships for seedlings with shallow rooting depth and that are not located near a groundwater level recorder. FWS seems to suggest that AEA should conduct continuous onsite water-level and soil moisture measurements because such measurements would be more sensitive, especially if germination and establishment occur on sites where soil moisture within the shallow rooting zone comes primarily from precipitation. FWS also seems to suggest that the RIP-ET module of MODFLOW, used to account for evapotranspiration, is insufficient to predict plant response.

FWS then states that xylem isotopic analyses would help identify the soil-water source, but that such analysis would only provide information for one point in time, unless regular (i.e., daily) measurements are taken. FWS recommends that local precipitation and the water table level be reported along with xylem isotopic data to account for recent precipitation that maybe perched on the water table. FWS recommends that these details be incorporated into the study.

Discussion and Staff Recommendation

Groundwater wells with continuously recording data loggers would be installed in all focus area vegetation types (see Riparian Botanical Study 11.6), and meteorological stations would collect precipitation and temperature data in each focus area. This information would be analyzed with seedling plot data and vegetation type sample data to develop vegetation flow response curves. The primary data source used to develop vegetation flow response curves would be groundwater measurements at individual well points with pressure transducers collecting data in 15 minute increments (see Study 7.5 (groundwater)). MODFLOW would then be used to quantify the range of relationships between floodplain surfaces, vegetation types, and groundwater that would not be possible with well data alone. The accuracy of MODFLOW would be validated by comparing measured water levels from wells with simulated water levels from the model runs.

We discuss the use of RIP-ET and our recommendations in Study 7.5 (groundwater).

Continuous, daily sampling of groundwater levels beyond the proposed groundwater wells in remote locations would be difficult and excessively costly. The methods proposed by AEA are consistent with accepted methods (section 5.9(b)(6)), and would provide information necessary to support the design of the project, assess environmental effects, and evaluate proposed environmental measures.

Plant xylem water can reflect the isotopic composition of the plant's water source. AEA proposes to conduct isotopic analysis of xylem water from a portion of seedlings in focus areas to determine seedling water source, and assess how project operations may influence the availability of groundwater and soil water sources and seedling establishment. The study plan does not specify a schedule or number of sampling events for isotopic analysis. As pointed out by FWS and NMFS, a single xylem water isotopic analysis would provide only a snap-shot of seedling water source. However, daily xylem water sampling would be too intensive and costly and would not be needed to determine the relative importance of various water sources to plant establishment. Sampling multiple times over the growing season would improve understanding of how water sources may vary by species and meteorological conditions and how project induced changes in water levels would affect water source availability and vegetation condition.

Consequently, we recommend that AEA consult with the TWG on the sampling design for collecting plant xylem water; and file no later than June 30, 2013, the following:

1) A detailed description of the sampling sites, frequency, and schedule.

2) Documentation of consultation with the TWG, including how its comments were addressed.

Soil Profile Sampling

NMFS and FWS recommend that sediment grain size measurements be based on samples taken at each soil horizon in the sediment profile, rather than at equal depth increments along the profile, which could result in the mixing of horizons.

Discussion and Staff Recommendation

To assist in characterizing the role of erosion and sediment deposition in the formation of floodplain surfaces, soils, and vegetation, AEA would excavate soil pits from the surface to the historic channel bed, describe and measure soil stratigraphy using NRCS methods (Schoeneberger et al. 2002), and analyze sediment grain size over the entire sediment profiles. Neither AEA nor Schoeneberger et al. (2002) describe how grain size samples would be taken.

Soil horizons (the types and depths of layers in the soil profile) provide information about how and when soils developed, which is necessary to achieve the objectives of this portion of the study. Therefore, we recommend that the study plan be modified to specify that sediment grain size measurements would be based on samples taken at soil horizons, rather than at equal depth increments.

Vegetation Response Curves

FWS states that the proposed methods do not specify how water-level summary statistics (e.g., growing season cumulative frequency; 7-day, 10-day, and 14-day moving average; and arithmetic mean) would be evaluated and selected to develop riparian plant community/species response curves to hydroperiods. FWS identifies some of the benefits, downfalls, and similarities between Henszey et al. (2004) and Orellana et al. (2012). FWS recommends that, regardless of the statistics and response curves selected, testing the statistics for best fit, avoiding some ad hoc process, and discussing the methods and progress with the riparian technical working group be conducted. NMFS recommends that AEA continue to work with Henszey and the technical working group to develop vegetation response curves.

Discussion and Staff Recommendation

AEA would follow the methods of Henszey et al. (2004) to develop vegetation-flow response curves. Prior to developing vegetation flow response curves, Henszey et al. (2004), and more recently Orellana et al. (2012), evaluated a number of different water-level summary statistics to determine which were most strongly correlated with plant frequency and were thus most suitable for inclusion in the vegetation-flow response curves. Testing the statistics for best fit, as recommended by FWS, is a commonly accepted practice (section 5.9(b)(6). We recommend that AEA do so in consultation with the riparian technical workgroup. Methods of analysis should be reported in the initial and updated study reports.

Floodplain Vegetation Study Synthesis, Focus Area to Riparian Process Domain Model Scaling, and Project Operations Effects Modeling

NMFS and FWS state that they appreciate and concur with AEA developing spatially explicit GIS-based models to scale-up the study results and modeling from focus areas to riparian process domains. NMFS and FWS recognize that recent advances in GIS and numerical modeling have only recently made such an effort possible, but that there would likely be assumptions and pitfalls in developing the model. NMFS and FWS recommend AEA work closely with the riparian technical working group during model development. They also recommend that AEA make the model (or a simpler model if the model is too data-intensive) available to stakeholders to test outcomes of different project operational scenarios they may consider worth bringing forward for consideration.

Discussion and Staff Recommendation

Development of the model would likely be an iterative process based on the study results. Stakeholders should have an opportunity to weigh in on its development. Therefore, we recommend AEA include a schedule and plan for its development in either the initial or updated study report, as appropriate.

While we would not object to AEA providing stakeholders access to such models and we see the benefit to AEA of potentially narrowing the alternatives that might require analysis, the software used to run the models may be licensed to AEA or proprietary and; there may be limitations imposed by the state of Alaska on making such models available. Therefore, we do not recommend that such models be provided to stakeholders. Stakeholders would have an opportunity at various points in the ILP process (e.g., initial and updated study reports, preliminary licensing proposal, final license application) to identify specific project operation scenarios, which AEA would need to evaluate using the methods described in the study plan.

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

Applicant's Proposed Study

AEA proposes a study to describe the current fish assemblage, including spatial and temporal distribution and relative abundance by species and life stage in the Upper River mainstem and tributaries from the proposed dam site at RM 184 to the Oshetna River confluence at RM 233.4.

The goal of this study is to characterize the current distribution, relative abundance, run timing, and life history of resident and non-salmon anadromous species (e.g., Dolly Varden, humpback whitefish, round whitefish, Arctic grayling, northern pike, and Pacific lamprey), and freshwater rearing life stages of anadromous fish (fry and juveniles) in the Susitna River and tributaries above the proposed dam site. In addition to investigating the resident salmonid and non-salmonid fish species present in this part of the river, this study would also investigate the distribution and abundance of any observed anadromous fish above the dam site.

The study objectives are described below.

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 fish, juvenile anadromous salmonids, and the freshwater life stages of non-salmon anadromous species.

2) Describe seasonal movements of juvenile salmonids and selected fish species such as rainbow trout, Dolly Varden, humpback whitefish, round whitefish, northern pike, Pacific lamprey, Arctic grayling, and burbot within the hydrologic zone of influence upstream of the project by:

a. documenting the timing of downstream movement and catch using out-migrant traps;

b. describing seasonal movements using biotelemetry (PIT and radio-tags); and

c. describing juvenile Chinook salmon movements.

3) Characterize the seasonal age class structure, growth, and condition of juvenile anadromous and resident fish by habitat type.

4) Determine whether Dolly Varden and humpback whitefish residing in the Upper River exhibit anadromous or resident life histories.

5) Determine baseline metal concentrations in fish tissues for resident fish species in the mainstem Susitna River.

6) Document the seasonal distribution, relative abundance, and habitat associations of invasive species (northern pike).

7) Collect tissue samples to support Study 9.14 (fish genetics).

In addition to the study description provided in the RSP, AEA also filed a final Susitna River Fish Distribution and Abundance Implementation Plan (Implementation Plan) on March 1, 2013, that provides additional information on the sampling strategy, study site selection process, and field sampling procedures.

Specifically, the final Implementation Plan provides: (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. Pertinent information from the RSP and Implementation Plan is included in the discussion of AEA's proposed study methods below.

Because of differences in stream channel characteristics between mainstem and tributary habitats, AEA proposes to implement different sampling strategies throughout the study area, as described below.

Upper River Mainstem Sample Design and Study Site Selection

The RSP proposes a sample design for the Upper River mainstem that would include selecting sampling sites from within a nested stratified sampling scheme using the habitat classification hierarchy described in Study 9.9 (aquatic habitat mapping)[36] where six replicate sampling sites would be selected within each level 3 habitat type for fish distribution sampling (i.e., 27 sites) and one replicate of each level 4 habitat nested within each level 3 habitat would be selected for relative abundance sampling (RSP figure 9.5-2).

In the final Implementation Plan, however, AEA states that channel morphology in the Upper River would result in corresponding limitation in aquatic habitat mapping. Accordingly, AEA modified its sampling strategy for the Upper River mainstem in the final Implementation Plan and now proposes a systematic transect approach for Upper River sampling. This sampling strategy would include using a random start in the Upper River and equally spacing transects at 2.4-mile intervals for a total of 20 transects over about 49 river miles.

At each of the 20 transects, one randomly selected habitat unit of each type would be sampled over a length of 40 meters, with 240 meter lengths implemented where boat electrofishing is the selected sampling method. AEA states that Upper River transects may span two or on rare occasions three habitat types, and based on preliminary mapping AEA estimates that approximately one-third of the length of the Upper River mainstem that would be sampled would contain more than one, and up to three mainstem habitat types. In addition, one transect per geomorphic reach would be selected for relative abundance sampling, for a total of six transects out of 20. The remaining transects would be sampled for distribution only (e.g., single pass sampling).

Sampling would be conducted seasonally on the Upper River segment. Distribution results (i.e., fish observation locations) would be presented on maps. Relative abundance estimates (e.g., fish per unit area, CPUE) would be summarized by mainstem habitat type and gear type with appropriate statistical confidence intervals.

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[36] The hierarchical and nested classification scheme would be composed of the following five levels: (1) major hydraulic segment (i.e., Upper River, Middle River, Lower River), (2) geomorphic reach (i.e., 6 Upper River geomorphic reaches, 8 Middle River geomorphic reaches, and 6 Lower River geomorphic reaches), (3) mainstem habitat type (i.e., main channel, split main channel, braided main channel, side channel, tributary, side slough, upland slough, backwater, and beaver complex), (4) main channel mesohabitat (i.e., pool, glide, run, riffle, and rapid), and (5) edge habitat.

Upper River Tributary Sample Design and Study Site Selection

Tributaries upstream of Devils Canyon selected for fish distribution and abundance sampling include all known Chinook salmon-bearing tributaries and other tributaries that are not currently listed in ADF&G's Anadromous Waters Catalog (AWC; ADF&G 2012). Initially 20 tributary streams were selected for sampling based on: AWC catalog listings, drainage basin, historical sampling efforts, and the potential for impact/inundation from the project. These tributaries were screened for accessibility of sampling based on stream gradient, channel morphology (i.e., confined canyon), mesohabitat type (rapid and cascade), and physical access conditions. The screening resulted in seven tributaries known to be accessible or to have substantial length of accessible reaches, four tributaries with unknown access, and nine tributaries that are inaccessible.

The accessible portion of each selected tributary to the 3,000-foot elevation contour was divided into population units of equal lengths based on channel width and drainage basin area. AEA states that population unit length equal to 20 channel widths is expected to contain a good distribution of habitat types, which is useful for distribution and abundance sampling. However, it also states that recent channel width data are not yet available, and the units within each tributary should be equal in length. Therefore, it proposes an additional stratification to divide tributaries into three different groups based on drainage areas and historic channel width data, where available (Saunter and Stratton 1983). Large tributary streams with drainage basins greater than 1,000 square kilometers and with channel widths of 35-45 meters were assigned 800-meter sampling units. Tributaries with drainage areas ranging from 300 to 1,000 square kilometers and with channel widths of 15-35 meters were assigned 400-meter sampling units. Tributaries draining less than 300 square kilometers and with channel widths of 5-15 meter were assigned 200-meter units. Within each tributary, sampling locations would comprise a target of up to 25 percent of the length of the tributary to the 3,000-foot elevation contour.

The seven accessible or partially accessible tributaries and the four tributaries where access conditions are unknown were subjected to a statistical sampling design. A generalized random tessellation stratified (GRTS) sampling method (Stevens and Olsen, 2004) was used to select study units within each tributary. Specifically, the GRTS routine in package "spsurvey" (Kincaid and Olsen, 2012) for R (R Core Team, 2012) was used to generate the GRTS samples. This sampling method is a compromise between random and systematic sampling that allows random ordering of population units with spatial balance. A systematic sample design would also work for the tributaries upstream of Devils Canyon. However, the accessibility of each selected location cannot be determined with certainty before sampling begins. With a systematic sample, loss of a sampling location in the field compromises the spatial coverage of the design and the overall sample size. Using the GRTS samples, oversampling is allowed (e.g., selecting 10 samples but planning to use only the first three); if selected samples are determined to be inaccessible in the field, the next sample on the randomized list can be used while maintaining spatial balance in the final sample set.

For each selected tributary, the accessible length of tributary was divided into equal length population units as described earlier, and the GRTS sample was drawn. No estimates of variance in relative abundance on these tributaries are available at this time, so sample sizes were not estimated via statistical power analysis. Instead, the sample size is based on a targeted percent coverage of the accessible population for distribution sampling and 10 percent coverage for abundance sampling. For example, if there are 100 population units on a given tributary, 25 were selected for distribution sampling, and the first 10 of these would also be used for relative abundance sampling. There is a minimum sample size of three units for abundance sampling in each tributary.

If possible, each mesohabitat unit (e.g., pool, riffle, glide, and cascade) within the selected sample units would be counted and measured using video and aerial imagery from habitat mapping efforts. For some tributaries, this would only be possible in the field. After surveying, one unit of each mesohabitat type would be randomly selected for sampling, and a 40-meter sub-sample would be sampled. If the selected unit is smaller than 40 meters in length, the entire unit would be sampled and a second random unit would be sampled until the target of 40 meters is obtained.

For the nine tributary streams with minimal to moderate access and limited feasible sampling areas, a direct sampling methodology would be implemented. For these identified streams, an average effort of two days would be conducted. Sampling effort would be as follows: smaller streams would be sampled for a single day, moderate sized and accessible streams for two days, and larger more accessible streams for three days. The goal of sampling is to distribute effort over the accessible study area in three locations. Where possible, the three locations would represent differences in elevation or other habitat features. Where aerial still or video imagery is available, proposed sample locations would be identified and reviewed prior to field activity. Habitat observed from the imagery at identified locations would be documented and field teams would attempt to sample pre-identified habitat units. Where imagery is unavailable, sampling location and effort may be determined during the first sampling effort for each tributary. Effort at each habitat unit would be considered done when the field lead judges that the unit was sufficiently represented or that additional sampling effort would not provide additional data. Sampling would occur seasonally (i.e., every other month from May through October).

Distribution results (i.e., fish observation locations) would be presented on maps. Relative abundance estimates (e.g., fish per unit area, CPUE) would be summarized by tributary, habitat type, and sampling method with appropriate statistical confidence intervals for GRTS samples. These estimates would apply only to segments of the tributary that were included in the statistical sample (i.e., the accessible portions of the tributary).

Field Techniques for Fish Distribution and Relative Abundance Sampling

A combination of active and passive fish sampling techniques would be used to document fish distribution and abundance. Sampling gear types to be used include: gillnets, beach seines, fyke nets, angling, trotlines, boat and backpack electrofishing, minnow traps, fishwheels, outmigrant traps, snorkeling, DIDSON sonar, and underwater video camera techniques. The techniques selected include those used by Alaska DFG in the 1980s as well as more advanced technologies that are now available. Selected methods for each sample unit would vary based on habitat characteristics, season, and species/life histories of interest. Logistical and safety constraints inherent in fish sampling in a large river in northern latitudes would play a role in selecting appropriate techniques under various site conditions. Some survey methods may not be used in the mainstem river immediately upstream of hazards such as cascades and rapids. All fish sampling and handling techniques described within the final Implementation Plan would be conducted under state and federal biological collection permits, as applicable. Limitations on the use of some methods during particular time periods or locations may affect the ability to make statistical comparisons among spatial and temporal strata.

PIT Tagging

PIT tag antenna arrays with automated data logging would be used at selected side channel, side slough, tributary mouth, and upland slough sites to detect movement of tagged fish into or out of the site. A total of two stationary PIT tag interrogation systems are proposed in the Upper River.[37] Potential locations were evaluated based on a review of existing data on fish distribution and habitat, the anticipated physical conditions and debris load at potential sites, and logistics for deploying, retrieving, and maintaining the

[37] As described in Study 9.6 (middle and lower river fish distribution), three additional PIT tag detection sites would be established in the Middle River study area and one additional detection site would be established in the Lower River study area.

antennas. The Upper River locations include one site in the Oshetna River near its confluence with the Susitna River (RM 233.4), and one site in Kosina Creek at the confluence with Tsisi Creek. Upper River locations would be co-located with outmigrant trapping efforts to maximize data collection at these remote sites. In the Upper River, Chinook salmon are the only anadromous salmon species present and have only been observed in limited numbers at a few locations. Therefore, suitable PIT tag detection sites that are in close proximity to areas where Chinook salmon spawning or juvenile rearing has been documented are scarce. In the Upper River, potential sites are limited to: Kosina Creek (adults and juveniles), Oshetna River (juveniles; Buckwalter 2011; HDR unpublished) or the main channel of the Susitna River between the confluence of the Oshetna River and the proposed dam site (RM 184). Of these sites, the Oshetna River, near its confluence with the Susitna River (RM 233.4) and Kosina Creek (RM 206.8) near its confluence with Tsisi Creek are proposed for PIT tag arrays. These sites have been identified as locations where hydrologic conditions may be favorable and logistics may be feasible for antenna deployment. The placement of an interrogation system near the mouth of the Oshetna River would also help to gather information on resident species including Arctic grayling, Dolly Varden, and round whitefish. A second array, located at the confluence of Tsisi Creek with Kosina Creek, would provide an opportunity to gather information on juvenile Chinook salmon in the Upper River study area as Chinook salmon spawning has been documented in Kosina Creek upstream of this location; lower reaches of Kosina Creek are not easily accessible due to topography and steep gradient. Several target resident species are found in Kosina Creek including: Arctic grayling, Dolly Varden, and round whitefish.

The target species for PIT tagging in the Upper River are juvenile Chinook salmon and the following resident fish species: rainbow trout, Dolly Varden, humpback whitefish, round whitefish, northern pike, Arctic lamprey, Arctic grayling, and burbot. The target number of fish for PIT tagging is 1,000 fish per species per PIT tag interrogation site; however, in the Upper River all captured juvenile Chinook would be tagged.

Downstream Migrant Tagging

AEA proposes to deploy two rotary screw traps in the Upper River segment[38] during the 2013 and 2014 field seasons. To identify specific trap locations within each of these hydrologic segments, potential rotary screw trap locations were evaluated based on:

[38] As described in Study 9.6 (middle and lower river fish distribution), three additional rotary screw taps would be deployed in the Middle River study area and one additional trap would be deployed in the Lower River study area.

(1) a review of existing data on fish distribution and habitat; (2) anticipated physical conditions and debris loads at potential sites; and (3) logistics for deploying, retrieving, and maintaining the traps.

In the Upper River, proposed trap locations include suitable trapping sites in close proximity to two of the limited areas where adult Chinook salmon spawning activity or juvenile rearing has been documented. The Oshetna River near the confluence with the Susitna River (RM 233.4) and Kosina Creek (RM 206.8) near the confluence with Tsisi Creek have been identified as locations where hydrologic conditions are thought to be logistically favorable for the deployment of outmigrant traps. In addition to juvenile Chinook salmon, a variety of resident species including Arctic grayling, Dolly Varden, longnose sucker, round whitefish, and slimy sculpin have been recently documented in the Oshetna River drainage. Thus, the placement of an outmigrant trap near the mouth of the Oshetna River may also gather information on resident species. The Tsisi Creek and Kosina Creek confluence, located approximately seven river miles upstream of the Susitna River, provides an opportunity to gather information on juvenile Chinook salmon in the Upper River study area. This trap location was chosen because the lower reaches of Kosina Creek are not easily accessible due to topography, and trap siting would be difficult because of the steep gradient. In addition, Chinook salmon spawning has been documented in Kosina Creek upstream of the Tsisi Creek confluence.

Flow conditions permitting, rotary screw traps would be fished on a cycle of a 48 hours on and 72 hours off throughout the ice-free period. Rotary screw traps would be checked at least once per day. Morning check (05:00-10:00) and evening (18:00-23:00) checks are preferred in order to determine if fish movement occurs primarily at night or during the day. During periods of migration or high flow, traps may need to be checked more often.

To produce reliable estimates of relative abundance from rotary screw trap field data, estimates of trap efficiency are needed. AEA proposes to use Peterson mark-recapture methods to conduct a series of trap efficiency experiments over the course of the sampling season. Trap efficiency is estimated as the proportion of marked fish appearing in a random sample and equates to the proportion of marked fish in the total population, provided that certain assumptions are met. The basic assumptions of the Peterson method that apply to trap efficiency estimates include: (1) the population is closed; (2) all fish have the same probability of capture in the first sample; (3) the second sample is either a simple random sample, or if the second sample is systematic, marked and unmarked fish mix randomly; (4) marking does not affect catchability; (5) fish do not lose their marks; and (6) all recaptured marks are recognized.

A stratified mark-recapture design would be implemented to estimate the relative abundance of downstream migrants over short discrete time periods (i.e., 7 days) in which trap efficiency is paired with a recapture period. If numbers are sufficient, a minimum of 100 fish representative of the day's catch would be marked and released weekly. If only a portion of the daily catch is to be used for efficiency trials, fish would be randomly selected, measured for length, marked, allowed to recover, and released during the time period of their migration (i.e., day or night). The release location of marked fish is to be located far enough upstream so that marked fish can evenly mix with unmarked fish moving downstream, yet not so far upstream as to cause an extracted period of migration of marked fish over multiple days and expose fish to predation. Based on recommendations by Volkhardt (2007) and Roper (1995) and estimated lengths of mesohabitat units, marked fish would be released 300 meters upstream of the trap location. Marked fish would be released evenly across the width of the river if feasible, or equally along each river bank in calm water. Fish holding time would be minimized to less than 48 hours.

Radio Telemetry

AEA proposes to use radio telemetry as a remote monitoring technique to obtain spatial and temporal distribution data for individual resident and non-salmonid anadromous species. Target species for this study component are: arctic grayling, burbot, Dolly Varden, humpback whitefish, lake trout, longnose sucker, northern pike, rainbow trout, and round whitefish. Fish locations and movements would be tracked using fixed-receiver stations and mobile tracking to record time and date stamped, radio-coded signals from tags implanted in fish.

AEA proposes to use Advanced Telemetry Systems (ATS) telemetry equipment to monitor fish species. AEA notes that use of ATS equipment directly constrains the potential options for tagging and monitoring. More specifically, the smallest ATS coded tag weighs 6 grams and thus requires fish to weigh at least 200 grams for effective application. For some species, such as Dolly Varden, only the largest individuals captured would be tagged based on the length–frequency distribution. It is likely that each of the nine target species would have a proportion of individuals that are too small to radio-tag.

To accomplish the goals of this study, four different sized radio tags would be used with expected operational lives ranging from 180 to 901 days. The ATS model 1810C, 1815C, 1820C, and 1830C tags have minimum tagging weights of 200, 233, 267, and 367 grams, respectively. The tags would be programmed to operate in slow pulse mode with 12 pulses per minute in order to extend the operational life of the tags as much as possible. All tags would be equipped with a motion sensitive sensor to alert biologists when a tag has remained motionless for 24 consecutive hours. Based on the number of tags to be released, AEA anticipates that seven radio frequencies would be needed for this study.

Fish would be captured opportunistically during sampling events targeting adult fish and with directed effort using a variety of methods. Preference would be given to fish caught with more benign techniques that cause minimal harm and stress to fish. Fishwheels targeting adult salmon (Study 9.7, salmon escapement) located in the Middle River near Curry (RM 120) and in lower Devils Canyon (~RM 150-151) may be used to opportunistically collect some target species. Other techniques including angling, electrofishing, fyke nets, hoop traps, trot lines, and seines would be used in coordination with fish distribution and abundance sampling efforts or to specifically target species and/or locations for tagging purposes.

Tags would be surgically implanted in 60 fish of sufficient body size (i.e., ≥200 grams) of each target species. For each species, 30 tags would be allocated to the Upper River, and 30 tags would be allocated to the combined Middle/Lower River. AEA anticipates post-tagging survival to be 80 – 100 percent based on previous radio telemetry studies.

AEA states that in some reaches of the Susitna River, certain species may not be available in large enough quantities to fulfill the tagging goals. If this occurs, the unused tags will be reallocated to species which are more numerous. Efforts would be made to tag fish in focus areas and at other sites where fish inventory activities would be implemented. Spatial and temporal distribution of tags within each river reach would be determined by the sampling schedule of Study 9.5 (upper river fish distribution) and Study 9.6 (middle and lower river fish distribution), and the availability of fish of each target species.

Radio-tagged fish would be tracked by detections at fixed receiver stations and aerial surveys. Fixed stations would include those used for Study 9.7 (salmon escapement), and five additional fixed stations would be established at strategic locations in the Middle/Lower River, and three additional stations would be added in the Upper River with input from the TWG. AEA proposes to service these stations in conjunction with Study 9.7 during the July through October period and during dedicated trips outside this period. Data from fixed-receiver stations would be downloaded as power and storage capacities necessitate and up to twice monthly during the salmon spawning period (approximately July through October). Study 9.7 would provide approximately weekly aerial survey coverage of the Middle/Lower River (approximately July through October) and coverage of the Upper River as salmon distribution dictates. At other times of the year, the frequency and location of aerial surveys would be monthly.

Fixed-station receiver sites for Study 9.7 would be operated at ten strategic locations in the Middle and Upper River including: Lane Creek Station (RM 113.0), Gateway (RM 125.5), Fourth of July Creek (RM 131.1), Indian River (RM 138.5), Slough 21 (RM 141.1), Portage Creek (RM 148.8), Cheechako Station (RM 152.4), the Chinook Creek confluence (RM 157.0), Devils Station (RM 164.0, located upstream of the Devils Creek confluence), and the Kosina Creek confluence (RM 206.8). The locations for the eight proposed resident fish stations, include: Montana Creek confluence (RM 77.0), Whiskers Creek confluence (RM 101), Indian River confluence (RM 138.6), Portage Creek confluence (RM 148.8), Fog Creek confluence (RM 176.7), Watana dam site (RM 184.0), Watana Creek confluence (RM 194.1), and Oshetna River confluence (RM 233.4). Both adult salmon and resident fish frequencies would be programmed on all radio telemetry receivers as appropriate in time and space.

Aerial surveys conducted for Study 9.7 (salmon escapement) would provide approximately weekly aerial survey coverage of the study area from approximately July to October and at least monthly during other periods. Using the guidance of fixed-station and aerial survey data on the known positions of tagged fish, specific locations of any concentrations of tagged fish that are suspected to be spawning would be visited to obtain individual fish positions. Aerial surveys targeting radio-tagged salmon would be conducted in the mainstem Susitna River from RM 22 to Kosina Creek (RM 206.8). If radiotagged fish are detected moving upstream in the mainstem at the Kosina Creek telemetry station, aerial surveys would be geographically extended to locate those radio tagged fish. In addition to aerial surveys, foot and boat surveys would be conducted from approximately July to October as part of Study 9.7. Spatial and temporal allocation of survey effort would be finalized based on the actual locations and numbers of tagged fish for each species. Aerial surveys to track radio-tagged resident fish would be conducted at least monthly from November to June between RM 61 and RM 230. The goal for helicopter-based surveys is to record a position within approximately 300 meters (1,000 feet) of a target tag, as well as to determine whether the fish is in off-channel or mainstem habitat. Forward and downward looking antennas would assist in determining tag locations effectively. At least four receivers would be used to minimize the number of frequencies scanned per unit. Geographic coordinates would be recorded for each detected signal using an integrated communication link between the telemetry receiver and a global positioning system (GPS) unit.

Mobile telemetry surveys may also be conducted by boat, snow machine, and foot to obtain the most accurate and highest resolution positions of fish. Using the guidance of fixed-station and aerial survey data on the known positions of tagged fish, specific locations of any concentrations of tagged fish that are suspected to be spawning can be visited to obtain individual fish positions. Spatial and temporal allocation of survey effort will be finalized based on the actual locations and numbers of tagged fish for each species. The channel location (mainstem, side channel, slough) and relative water turbidity at the location of the fish would be classified for each tag detected (time stamp, frequency, code, power level) during aerial surveys. If other fish can be seen in the area of the tag position, their relative abundance would be visually estimated to provide context for the tag observation. Tag identification, coordinates, and habitat type data would be archived and systematically processed after each survey. A data handling script would be used to extract unique tag records with the highest power level from the receiver files generated during the survey. These records would be imported into a custom database software application (Telemetry Manager) and incorporated into a (GIS) based mapping database. Geographically and temporally stratified data of radio-tagged fish would be provided to the habitat and instream flow study teams to inform their field sampling efforts.

Fish Tissue Sampling

Fish tissue samples for determining baseline metal and mercury concentrations would be collected opportunistically in conjunction with all fish capture events. The primary role of the fish distribution and abundance survey crew for this study is to provide captured fish to a trained field technician, who will be responsible for fish tissue sample collection. The field technician would be provided by the study team for Study 9.8. Fish tissue samples would be collected from adult salmon carcasses, as well as juvenile Chinook salmon, juvenile coho salmon, and juvenile and adult rainbow trout. To account for temporal variability in isotopic signatures, samples would be collected at the selected focus area sites during the spring, summer, and fall season.

Fish tissue samples for use in Study 9.14 (genetics) would be collected as part of fish distribution and abundance surveys and focused primarily on: (1) Pacific salmon spawning in the Upper River and Middle River segments, (2) juvenile Chinook salmon habitat use in the Lower River, and (3) resident and non-salmon anadromous species in the Upper River and Middle River segments. Specific details regarding target sample locations, species, life stages, and annual sample sizes for genetics analysis are provided in Study 9.14.

Fish Gut Content Sampling

Juvenile Chinook salmon, juvenile coho salmon, and juvenile and adult rainbow trout captured during the fish distribution and abundance studies in the Upper River and Middle River would be used for stomach content samples to support the Study 9.8 (river productivity) objectives. Stomach content sampling would be performed by a trained field technician provided by the Study 9.8 study team. The technician would accompany fish survey crews to selected study sites, where planned fish distribution and abundance surveys would occur. In the Middle River, gut samples would be collected at the four Middle River focus areas selected for intensive study in Study 9.8. In the Upper River segment, stomach content sampling would be conducted on a more opportunistic basis. That is, initial fish distribution and abundance study findings may be used to increase the likelihood of encountering target species and life stages in the Upper River prior to the stomach sampling technician accompanying the fish survey crew in the field. However, the fish survey crew would adhere to the site selection and sampling designs for fish distribution and abundance sampling to avoid biased results and thus, would not actively target species for stomach content sampling.

Winter Sampling

AEA proposes to conduct a pilot study at the Whiskers Slough focus area (RM 101-102) within the Middle River during the winter of 2013. AEA states that Whiskers Slough was selected because: (1) it contains a diversity of habitat types, (2) sampling in the 1980s and 2012 revealed the presence of spawning and rearing salmon and resident fishes (Schmidt et al. 1983), and (3) it is relatively accessible from Talkeetna. The pilot study would evaluate the effectiveness and feasibility of winter sampling methods including: underwater fish observations via DIDSON sonar and underwater video, minnow traps, seines, electrofishing, trotlines, PIT tags, and radio tags. The pilot study would also be used to evaluate the feasibility of sampling during spring break up; assess winter sampling logistics, including safety, sampling methods in different habitat types under varying degrees of ice cover, transportation and site access logistics, travel time, and winter-specific gear needs; and develop recommendations for subsequent winter studies beginning in the late fall of 2014. Ultimately, the objectives of the winter fish studies would be to: (1) document the distribution of juvenile salmonids and non-salmonid resident fish in winter; (2) describe seasonal movement, timing, and habitat use by juvenile salmonids at selected focus areas in winter; and (3) determine diurnal activity of juvenile salmonids at selected focus areas in winter.

Winter fish sampling would employ multiple methods to determine which are most effective for each fish species, lifestage, and habitat type. Because sampling efforts would occur at both open leads and ice covered sites, methods would vary depending on conditions. In ice-covered sites, the primary sampling methods would be trotlines and minnow traps. In open leads, fish capture methods would include baited minnow traps, electrofishing, and beach seines. Remote telemetry techniques would include radio telemetry and PIT tag technology. AEA states that both of these methods need to be tested for tag detectability under ice cover. All fish sampling would occur approximately monthly from February through April 2013 and would be coordinated with the intergravel temperature monitoring and the underwater fish observation components.

Relational Database

AEA proposes to develop a database template to store the fish distribution and abundance data from all consultants and studies, providing a centralized data tool for users. The final database would be maintained in Microsoft Access software and would include data collected in 2012 and new data from future studies in 2013 and 2014. The database would be available for querying and analysis by an unspecified number of entities that are as-yet unidentified by AEA.

A data dictionary describing the database entities and attributes would be compiled, to accompany the database and to provide an understanding of data elements and their use by anyone querying or analyzing the data.

Comments on the Study

Tributary Sampling Locations

NMFS and FWS state that within tributary sampling, classified mesohabitats should be retained as the sampling unit for stratified random sampling using GRTS methodology and 25% of the classified habitat or a minimum of 6 replicates of each habitat should be selected for abundance and distribution sampling in each stream.

Discussion and Staff Recommendation

AEA has not proposed to classify mesohabitat units throughout the entire tributaries, citing substantial feasibility challenges both in accessing rivers to conduct habitat typing, and feasibility challenges to conduct sampling. Instead, AEA proposes to select sample locations from within each tributary of varying length based on drainage area, and conduct fish sampling from within those locations. The proposed sampling approach appears sufficient because the objective of this component of the study is relative abundance and distribution, and not an estimate of total abundance of each tributary. In addition, feasibility is a legitimate concern, with significant cost implications (section 5.9(b)(7)). If habitat units were selected for sampling from within the entire tributary it is highly probable that a high proportion of units would be from areas that are challenging and expensive to access. AEA's proposed approach strikes a reasonable balance between sampling a representative proportion of a variety of tributaries in a feasible and repeatable manner.

No modifications to the study plan are recommended.

Mainstem Sampling Locations

NMFS and FWS state that the proposed systematic selection of sampling locations in the Upper River mainstem based on 20 transects is not likely to provide adequate replication of mainstem macrohabitats. NMFS and FWS recommend that classified habitat units: main channel, side channel, side slough, upland slough, and tributary mouths (not units of habitat length) could be selected using the proposed GRTS methodology.

Discussion and Staff Recommendation

In section 9.5.4.1 of the RSP, AEA proposed a nested stratified sampling scheme for describing fish distribution and abundance in the Upper River study area, which is an approach that would be consistent with NMFS and FWS' recommendations. However, in section 5.4 of the final Implementation Plan, AEA modified its sampling design and proposed a systematic transect-based approach. The systematic approach would include selecting sampling sites along whatever habitat units are encountered within transects equally spaced every 2.4 miles throughout the 49-mile-long study area, for a total of 20 sampling locations. AEA's justification for fundamentally modifying its sampling strategy is that channel morphology in the Upper River would result in corresponding limitations in aquatic habitat mapping. AEA provides no additional detail on why it modified its proposed sampling strategy between the RSP and Implementation Plan.

It is unclear why AEA contends that there are limitations in aquatic habitat mapping in the Upper River mainstem because section 4.4.2 of the Implementation Plan specifies that AEA already mapped aquatic habitats in the Upper River mainstem to the mesohabitat level in 2012 using geo-rectified aerial imagery in combination with available aerial videography. Assuming that this section of the Implementation Plan is accurate, it appears that AEA would already have the information it needs to implement a stratified study design.

While it is reasonable to conclude that the agencies recommended stratified study design would provide a better representation of fish-habitat relationships and relative abundance throughout the study area, either sampling strategy would provide some information to characterize the existing distribution and abundance of the predominately resident fish community upstream of the dam site (section 5.9(b)(5)), which would be necessary to evaluate the anticipated significant effects of permanently modifying aquatic habitat and the existing fish community through proposed dam construction and reservoir inundation. However, for the reasons discussed below, we conclude that implementing a study using a stratified random sampling design that includes all levels of AEA's proposed classification scheme would likely require a substantial additional effort and cost when compared to the proposed transect-based design.

We envision that a stratified sampling design would, at a minimum, require between one and several replicates of each main channel and side channel habitat unit, and between one and several replicates of each off-channel macrohabitat unit, which would be randomly distributed within each of the six Upper River geomorphic reaches. Assuming that this strategy results in a minimum of seven sampling sites per geomorphic reach,[39, 40] it would likely require a total of a minimum of 42 sampling sites throughout the Upper River study area. The stratified sampling design would therefore result in a doubling of effort when compared to the transect-based approach (i.e., 20 versus 42 sampling locations). In addition to the additional costs associated with a doubling of the sampling effort, the transect based approach would confine the sampling sites to discrete portions of the river such that once a field sampling crew is in place, all sampling within approximately 2.5 river miles would be confined to one location along the transect. On the other hand, a stratified sampling design using the GRTS model would randomly distribute the seven or so sampling sites within each geomorphic reach such that field crews and sampling equipment would repeatedly be moved to various locations throughout each geomorphic reach to conduct the required sampling effort, thereby resulting in additional costs for mobilizing and setting up field crews and sampling equipment. In the circumstances of this case, the proposed study area is 49 miles long and located within an extremely remote area; therefore, the costs of repeatedly mobilizing and setting up field crews and sampling equipment using helicopters, boats, and remote camps to accommodate a stratified random sample design would likely be very high (section 5.9(b)(7)).

No modifications to the study plan are recommended.

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[39] It is not possible to determine the appropriate number of sampling sites to ensure adequate replication without first reviewing the preliminary habitat mapping results, which does not appear to be in the project record.

[40] AEA appears to omit geomorphic reaches from its stratified sampling strategy presented in the RSP for Upper River fish sampling, so it is unclear whether it previously intended to conduct this level of effort; however, it is our understanding that geomorphic reaches would need to be included for the study to be implemented consistent with AEA's channel classification system and accepted practices. There are other ways to implement a stratified sampling strategy and minimize effort (i.e., pooling similar geomorphic reaches and sampling replicates within similar reaches), but it is our understanding that AEA did not propose that approach in the RSP.

Tributary Sampling Lengths

FWS states that within tributary sampling, the sampling area should include the entire classified habitat for those less than 200 meters, 400 meters, or 800 meters as proposed based on basin area, or sampling units of these lengths, whichever is smaller.

Discussion and Staff Recommendation

AEA does not appear to provide any legitimate scientific basis for its proposed 40-meter subsample length, and there is no information in the study plan or the scientific literature to conclude that this approach is consistent with scientifically accepted practices (section 5.9(b)(6)). Because fish are often unequally distributed even within mesohabitats (Nielsen, 1992) different results could be obtained depending on the location of the sub-sample within the habitat unit. Site access appears to be the largest obstacle to sampling feasibility; therefore, once a sampling crew is in place, sampling a larger area (i.e., up to 200, 400, or 800 meters in length) would be only slightly more expensive, and should result in a relatively low incremental cost. The incremental additional cost of sampling a larger area would be justifiable to obtain data that is sufficient to meet the study objectives of characterizing fish distribution and relative abundance in tributaries that would be inundated by the project (section 5.9(b)(7)).

We recommend that the sampling unit lengths for the seven accessible tributaries and four tributaries with unknown accessibility that would be subject to the GRTS sampling design, as specified in section 5.2 of the Implementation Plan, include the entire classified mesohabitat for those units less than 200 meters, 400 meters, or 800 meters in length (as proposed based on basin area) or sampling units of these lengths, whichever is smaller, rather than the proposed 40-meter subsample.

Mainstem Sampling Lengths

NMFS and FWS state that 40-meter sampling units are too small for all mainstem habitat classes. NMFS and FWS state that sampling units should be proportional to channel or off-channel habitat width. Alaska DFG states that 40-meter sample units may be problematic because the capture efficiencies for the gear type would vary greatly. Alaska DFG further states that in main channel sampling units some of the gear cannot be set or fished as intended, which would result in a biased catch-per-unit-effort estimate because the gear would have a capture probability of zero. Alaska DFG states that boat electrofishing is one of the most effective capture techniques in the mainstem Susitna River, and consideration should be given to increasing the length of the sampling reach to 20 times the wetted width of the channel, or 1kilometer (1,000 meters).

NMFS and FWS recommend that for main channel and side channel macrohabitats, sampling units should be 500 to 1,000 meters in length or the entire length of the macrohabitat unit, whichever is shorter, and should be sampled with boat electrofishing.

In addition, the agencies state that tributary mouths should include the backwater confluence with the mainstem and extend a minimum of 200 meters downstream, and side slough and upland slough sampling units should include the mainstem backwater confluence and extend a minimum of 200 to 300 meters up the slough.

Discussion and Staff Recommendation

AEA does not appear to provide any scientific basis for its proposed 40-meter subsample length in off-channel sampling locations, or its proposed 240-meter subsample lengths in main channel boat electrofishing sampling locations, and there is no information in the study plan or scientific literature to reasonably conclude that this would be an acceptable approach to capture fish distribution and abundance within these very large, main channel and off-channel macrohabitats, some of which would likely be greater than 1,000 meters in length (section 5.9(b)(6)). As stated above, fish are often unequally distributed within mesohabitats, and fish aggregations could be missed entirely if the sampling unit lengths are too small. AEA's proposed methods for subsampling habitat units in 40-meter or 240-meter increments, would likely result in a biased characterization of fish distribution and abundance because it would be directly related to whether the small subsample that is selected happens to be an area of particularly high or low fish density within a much larger habitat unit. Because its proposed methods would result in sampling relatively few habitat units and extrapolating these to a large geographic area, the bias is likely to have substantial implications for accurately characterizing the existing environment for fisheries resources of the project area and conducting the required analysis of project effects (section 5.9(b)(5)). Instead, an accepted approach as recommended by NMFS, FWS, and Alaska DFG, would be to implement a sampling unit length for all mainstem macrohabitats that is proportional to the channel width of the habitat unit (e.g., 20 times the wetted width), or the entire length of habitat unit, or 500 meters, whichever is less (section 5.9(b)(6)).

For side slough and upland slough habitats, a sample unit length of 200 meters or the entire slough, whichever is less, as recommended by the agencies would likely be adequate to capture habitat (and fish density) variability within slough habitats. Sampling the entire slough or 200 meters, whichever is less, as recommended by NMFS and FWS, is both consistent with accepted practices (section 5.9(b)(6)) and should be a reasonable level of effort to meet the study objectives. In addition, we find that the agencies' request that AEA initiate sampling at the lowest end of all sloughs where they connect to the mainstem (and backwaters are formed) appears to be based on the agencies' site-specific knowledge that these areas provide a disproportionate level of use by target species, and if not included, could result in the under-representation (or omission) of one or more target species. Sampling up to 200 meters, or the entire slough length, should adequately represent habitat conditions in the remaining length of sloughs. Similar to our analysis regarding the appropriate sampling unit length for main channel and off-channel habitats, sampling 40-meter lengths at tributary mouths appears to be an inadequate level of effort that does not appear to be based on any scientifically accepted practices (section 5.9(b)(6)). Instead, a reasonable approach, as recommended by the agencies, would be to extend sampling to include the backwater area within the tributary, if present, and a distance 200 meters downstream of the tributary mouth/confluence with the mainstem.

In regard to expanding the sampling unit length in all habitat types discussed above, we estimate that the majority of the cost incurred in fish sampling would be associated with the logistical effort of getting a crew and equipment to a sampling site, and that the incremental cost of increasing the area of sampling to the entire length of the habitat unit, or a length proportional to the wetted channel width and capped at either 200 meters (for sloughs) or 500 meters (for main channel and side channel units), or whichever is less, as appropriate, would be relatively low in comparison (section 5.9(b)(7)). This would especially be the case for boat electrofishing methods which may require more effort to set up than would actually be required to conduct the sampling.

We recommend that sampling unit lengths for all main channel and side channel habitat units be equal to 20 times the wetted channel width of the habitat unit, the entire length of the habitat unit, or 500 meters, whichever is less.

We recommend that sampling unit lengths for all slough macrohabitats encompass the entire length of the slough, a distance equal to 20 times the wetted channel width of the slough, or 200 meters, whichever is less. We also recommend that slough sampling be initiated at the downstream end of the slough.

We recommend that, to the extent possible based on site-specific field conditions, AEA sample all main channel and side channel macrohabitat units with boat electrofishing methods.

We recommend that AEA's proposed tributary mouth sampling unit lengths include the backwater area within the tributary, if present, and extend a distance 200 meters downstream of the tributary mouth/confluence with the mainstem.

Sample Timing

NMFS and FWS state that sampling in the spring should be initiated as soon as ice is out (i.e., mid- to late-May).

NMFS and FWS state that sampling to document summer rearing distribution and habitat associations should be conducted during two time periods, early to mid-July, and mid-August to early September.

NMFS and FWS state that winter sampling should be conducted to address specific hypotheses including migration timing of Chinook smolt based on the change in relative abundance of age-1 Chinook in mainstem and tributary habitats. NMFS and FWS state that winter/spring sampling (minnow trapping) should be conducted in open leads and through the ice to document the presence of smolt or overwintering fish among mainstem and tributary habitats.

Discussion and Staff Recommendation

AEA's proposal to sample seasonally with more frequent bi-weekly sampling immediately following ice-out to capture critical juvenile outmigration from natal tributaries appears to accommodate the agencies' request that AEA sample in the spring as soon as ice–out occurs.

In regard to summer sampling, AEA states in its Implementation Plan that fish distribution and abundance sampling would occur every other month from May through October. If sampling were to occur in May, July, and either late August or early September, which is certainly possible based on AEA's proposed sampling frequency, the proposed approach would be compatible with the NMFS and FWS requested sampling periods. It's not entirely clear when exactly sampling would occur, but AEA's approach as slightly modified by the agencies' request should not result in any additional effort or costs (section 5.9(b)(7)), and would be appropriate to characterize summer rearing conditions.

In regard to winter sampling, NMFS' comment lacks any specific detail on how the study plan should be modified to develop hypotheses based on changes in abundance of age-1 Chinook, so we have insufficient information to determine the appropriateness of its recommendation relative to AEA's proposed winter study methods. AEA's proposed initial study efforts for documenting winter fish use are limited to a pilot study to be implemented in the winter of 2013, with additional winter efforts to be determined in the fall of 2013 in consultation with the TWG based on the results of the pilot study. Due to the challenging and potentially dangerous field conditions that are present in the

Susitna River Basin during the winter, AEA's phased approach is reasonable in the circumstances of this case, and the proposed pilot study sampling methods appear to be consistent with scientifically accepted practices for winter sampling under ice conditions (section 5.9(b)(6)). There would be additional opportunities throughout ILP prefilling study implementation to evaluate the effectiveness of winter sampling methods and, if found to be effective, apply additional winter sampling efforts throughout the study area. These include the fall of 2013 as proposed by AEA, and in response to information contained in the Initial and Updated Study Reports (sections 5.15(c)(2) and 5.15(c)(4)).

We recommend that the proposed summer sampling events be conducted in mid-July, and again in either late August or early September.

Catch Per Unit Effort Metrics

NMFS and FWS state that fish sampling should provide catch per unit effort (CPUE) from electrofishing (boat or back pack) for each mainstem macrohabitat (main channel, side channel, side slough, upland slough, and tributary mouth) and for each tributary mesohabitat category.

NMFS and FWS state that CPUE information should be collected (e.g., catch per unit of time electrofishing) for both distribution and abundance sampling efforts. The agencies state that using CPUE from the first pass of the abundance collections and the single pass distribution CPUE would allow for direct comparisons among distribution and abundance sample sites.

NMFS and FWS state that fish sampling should provide catch per unit trap from minnow trapping (using 20 traps per 200 meter sampling reach soaked for 24 hours) for each mainstem macrohabitat (main channel, side channel, side slough, upland slough, and tributary mouth) and for each tributary mesohabitat categories. NMFS and FWS add that minnow traps should not be placed haphazardly within a sampling reach, but in locations most likely to capture fish (e.g., areas with cover) or that fish can occupy for extended periods of time (e.g., where water velocity is less than sustained swimming speeds of target fish).

Discussion and Staff Recommendation

In section 8.2 of the final Implementation Plan, AEA proposes to record fish capture data and sampling effort (i.e., electrofishing "power on" recorded in seconds) for both backpack and boat electrofishing separately so that CPUE can be calculated within each sample unit. This is consistent with the NMFS and FWS request, and is scientifically accepted practice (section 5.9(b)(6)). NMFS and FWS note that CPUE from multiple pass electrofishing is inaccurate, and that accurate and comparable CPUE data should only be based on the first pass. Although AEA is not clear on how CPUE from electrofishing would be calculated, we agree with the agencies' concerns. We note, however, that AEA is likely already factoring this into its analytical approaches, even though it's not explicitly stated in the RSP.

AEA has proposed to set 4–8 traps "haphazardly" for three hours for "distribution" sampling and 4–8 traps with three 90-minute soak periods for "abundance" sampling. Although the proposed three-hour soak time for distribution surveys is slightly higher than the 90-minutes NMFS and FWS responded to, there does appear to be potential problems with the proposed approach. We agree that the alternative proposed by NMFS and FWS using a 24-soak would likely result in better representation of fish distribution. Either trap density would probably be sufficient provided that the soak time is longer. We also agree that the use of minnow traps for abundance sampling is problematic, and not a generally accepted scientific practice (section 5.9(b)(6)). In addition, we agree with NMFS and FWS that there is general scientific consensus that minnow traps are more effective when placed in areas with cover and low water velocity, rather than placed haphazardly within a habitat unit.

AEA proposes that all methods would be conducted consistent with generating estimates of CPUE that are meaningful and facilitate comparison of counts or densities of fish over space and time. We agree with the agencies that it is not entirely clear how AEA would analyze and report CPUE data. However, AEA's proposed sampling approach should provide the information necessary to properly describe CPUE, and we envision that in initial and updated study reports AEA would clearly describe analytical methods.

We recommend that calculation of CPUE from electrofishing data be based only on the first pass, as requested by NMFS and FWS.

We recommend that minnow traps be soaked for 24 hours and placed within locations most likely to capture fish (e.g., low-velocity habitat in close proximity to cover).

Length Frequency and Condition Factor

NMFS and FWS state that fish sampling should provide length frequency distribution for each species for each sampling date and macrohabitat using combined data from electrofishing and minnow trapping and lengths of all captured fish.

NMFS and FWS state that fish sampling should also provide condition factor (length/weight^3 x 10,000) for all species on all sampling dates from weights of first 50 fish of each species at each sampling location.

Discussion and Staff Recommendation

AEA is already proposing to measure the fork length and weight of all captured fish during Upper River sampling. Therefore, the length frequency data would be available to summarize by species, sampling date, macrohabitat, and capture technique, as requested by NMFS and FWS. AEA also proposes to determine the condition factor for captured fish within each habitat type. It appears that these proposed methods and level of effort (section 5.9(b)(7)) are consistent with the agencies' request, and the methods are scientifically accepted practices (section 5.9(b)(6)) for collecting the data necessary to calculate length frequency distributions and condition factor for sampled fish.

No modifications to the study plan are recommended.

Use of Snorkel Dives to Evaluate Electrofishing and Minnow Trapping

NMFS and FWS state that snorkel surveys should be used in 10 percent of the clear-water habitats (blocked with nets) to evaluate and report the accuracy of abundance estimates from electrofishing and minnow trapping. The agencies state that, if differences in catch per unit effort or catch per unit trap are not proportional to snorkel abundance estimates, electrofishing effort and number of traps should be increased. The agencies comment that the use of snorkel surveys to test for sampling efficiency is a generally accepted practice in the scientific community (Joyce and Hubert, 2003; Korman et al., 2010).

Discussion and Staff Recommendation

AEA proposes to use snorkel surveys in combination with other techniques to estimate relative abundance, noting that use of snorkel surveys provides a calibration factor for the counting efficiency of other methods such as electrofishing and seining. However, a specific comparison approach is not proposed. It is generally assumed in the scientific community that electrofishing has a higher probability of detection than snorkel dives (e.g., Hankin and Reeves, 1988). Both citations noted by NMFS and FWS (Joyce and Hubert, 2003 and Korman et al,. 2010) found higher detection probability with electrofishing than with snorkeling for salmonids, especially for smaller individuals. Therefore, although comparing snorkel dives to electrofishing results is useful when both methods are used in the same area, using snorkel dives to evaluate the accuracy of estimates from electrofishing has no scientific basis (section 5.9(b)(6)). In contrast to electrofishing, minnow trapping has a very low capture probability, and it is likely that snorkel dives could be used to evaluate the accuracy of abundance estimates for minnow trapping. However, this additional sampling effort could result in substantial additional costs that would not be justified just to provide a rigorous comparison of methods (section 5.9(b)(7)).

No modifications to the study plan are recommended.

Fish Observed But Not Captured

NMFS and FWS state that the number of fish observed but not captured should be reported for each electrofishing sampling site and date.

Discussion and Staff Recommendation

AEA does not state if it intends to collect data on fish observed but not captured during electrofishing. Although there would be no substantial cost increase to collect these data (section 5.9(b)(7)), there is also no generally accepted scientific practice of recording fish observed but not captured during electrofishing events (section 5.9(b)(6)). Observations of fish not captured are not useful for any meaningful analysis since the total number of fish not captured can't be accurately enumerated, and if a fish of the same species is subsequently captured, there is no way to discern if it was previously recorded as not captured.

No modifications to the study plan are recommended.

PIT Tag Arrays

NMFS and FWS state that it would be very expensive to install and maintain two PIT tag arrays in the Upper River with minimal information returns. Alaska DFG recommends moving Upper River PIT tag arrays downstream, or removing the arrays altogether.

Discussion and Staff Recommendation

AEA's proposed approach is an accepted and proven method (section 5.9(b)(6)) for the use of half-duplex PIT tag antennas, and if implemented properly, should provide robust, reliable, and passive monitoring of fish migration at the two selected, Upper River PIT tag antenna sites. Although the data collected would be very precise, it would be limited in scope in that only two locations are proposed in the entire Upper River study area, and therefore, the data would be limited by the number of fish that could feasibly be

PIT tagged in the vicinity of the antennas. Should the initial study results (as documented in the Initial Study Report) suggest that the PIT tag methods provide little or no useable data, AEA could propose and/or the agencies could recommend that the PIT tag sites be abandoned at these locations and the efforts be reallocated to try different monitoring approaches to document fish movement and life history timing.

No modifications to the study plan are recommended.

Release of Tagged Fish

NMFS and FWS comment that, if results are to be evaluated based on the ratio of tagged fish crossing an array to total fish tagged, then PIT tagged fish from outmigrant traps released above the array would skew results toward downstream migrants. Thus, the agencies recommend that fish captured in outmigrant traps and PIT tagged, not be released upstream of the array.

Discussion and Staff Recommendation

Since each PIT tagged fish has a unique identification code, any fish released upstream of an array could be accounted for in the database for future analysis at relatively low cost.

No modifications to the study plan are recommended.

Growth Measurements

NMFS and FWS state that all PIT tagged fish should be weighed following tag placement so that growth rates based on change in weight can be calculated.

Discussion and Staff Recommendation

AEA is proposing to measure the length and weight of all captured fish to provide information on changes in length and weight (growth). Change in length and change in mass are both accepted practices in the scientific community (section 5.9(b)(6)). The NMFS and FWS concern regarding the weight of PIT tags could be addressed by either weighing fish after the PIT tag is inserted, or subtracting the weight of PIT tags after data are processed.

No modifications to the study plan are recommended.

Outmigrant Trap Locations

NMFS and FWS state that both outmigrant traps should be located within the mainstem Susitna River. NMFS and FWS suggest that positioning a trap on the mainstem Susitna below the mouth of Kosina Creek would provide information on Chinook salmon movement from a spawning tributary but also capture and document the timing of other downstream migrating anadromous and mainstem resident fish. The agencies recommend that a second trap located closer to the proposed location of the dam, at or below Deadman Creek, would provide a more accurate measure of the timing, species, life stage, and size of outmigrant fish that would require passage through the proposed dam location.

Discussion and Staff Recommendation

As noted above, AEA proposes to operate two rotary screw traps upstream of the dam site, one each within the Oshetna River and Kosina Creek, at the same general locations as the PIT tag arrays. Both of these tributaries are locations where Chinook salmon have been documented during previous sampling events in the basin. While both of these locations are reasonable for attempting to document the timing of downstream migrating juvenile Chinook salmon and other resident fish species from natal tributaries, they would not be sufficient for describing downstream migration patterns in the Upper River mainstem closer to the dam site. An additional mainstem trap closer to the dam site, if effective at capturing juvenile Chinook salmon, would provide valuable information on the downstream migration timing of this species that would be directly applicable to the required analysis of the benefits of constructing, and/or the timing of operation, of fish passage facilities at the dam (section 5.9(b)(5)). The operational timing of any potential downstream fish passage facilities could have a direct bearing on the feasibility of various project operating scenarios.

An additional mainstem trap would also be useful in providing additional information on mainstem fish use in light of the fact that AEA proposes a somewhat limited, systematic transect-based approach for characterizing mainstem fish distribution and abundance that may not capture any juvenile Chinook use of mainstem Upper River habitats. We estimate that the additional costs of operating one screw trap in the mainstem Upper River segment would be around $100,000 per year, including equipment and costs to install the trap (section 5.9(b)(7)). If an additional trap were added closer to the dam site in 2013, tributary trap data from 2013 could be compared to the mainstem trap data and would provide valuable information to compare data between the locations, which would enable a more-informed decision on the appropriate trap locations for 2014, especially if either tributary or mainstem traps end up providing little useful data.

We recommend that AEA install and operate one additional outmigrant trap in the mainstem Susitna River, downstream of the mouth of Kosina Creek near the proposed dam site. The actual location should be selected after consultation with the TWG.

Resident Fish Radio Telemetry Tagging

Alaska DFG states that currently, the number of radio tags to be deployed by species and area, especially in the Upper River, is insufficient to document spawning areas. Alaska DFG suggests that consideration should be given to increasing the sample sizes for various fish species, based on the initial results from tagging efforts in 2013.

NMFS and FWS state that adult grayling, rainbow trout, and Dolly Varden should be collected for tagging at tributary mouth sampling locations during the seasons immediately prior to their spawning migrations (i.e., early spring for grayling and rainbow trout, and early fall for Dolly Varden). The agencies contend that tagging should target larger fish, particularly those displaying spawning color or morphological changes. The agencies also recommend tagging adult whitefish prior to spawning migrations in early September, and burbot tagging to be conducted prior to fall or winter spawning migrations.

Discussion and Staff Recommendation

AEA's proposed level of effort for attempting to collect, radio-tag, and track a target of 30 fish of each resident fish species in the Upper River is consistent with scientifically accepted practices for documenting baseline, resident fish migratory behavior for hydroelectric licensing studies (section 5.9(b)(6)). We note, however, that it is not possible to predict at this time if the level of effort would be sufficient to document spawning distribution of resident fish. This is because there are numerous factors that would determine the success of meeting the study objectives, including the ability to capture the target number and appropriate size of fish, as well as the distribution of tagging locations throughout the study area. Most of these issues could not be fully evaluated until after an initial review of the study results. We therefore agree with Alaska DFG that it may be reasonable to increase the tagging effort for some species depending on the initial results from 2013. The ILP regulations already incorporate specific provisions that allow for modifications to the study plan based on the study results presented in the Initial Study Report (sections 5.15(c)(2) and 5.15(c)(4)).

AEA proposes to opportunistically capture adult resident fish during other adult fish studies, as well as with directed efforts specifically targeting fish for radio tagging pursuant to this study using a variety of methods. AEA states that up to 10 tags per species would be implanted in fish captured at tributary mouths; however, it does not specify the target timing or location for capture of each species of adult resident fish for radio-telemetry, other than noting that fish sampling would occur during spring, summer, and fall. It is theoretically possible that AEA could collect enough fish during its proposed sampling framework to target the species, locations, and seasons specified by NMFS and FWS for radio-tagging adult resident fish, and we agree with NMFS and FWS that targeting specific locations and times for tagging adult resident fish would increase the likelihood of documenting spawning migration timing and spawning locations, which would facilitate a better understanding of potential project effects (section 5.9(b)(5)). Provided that tagging is attempted and successfully completed within the sampling framework already specified by AEA, there should be no additional costs to incorporate the agencies' specific recommendations (section 5.9(b)(7)).

To the extent possible given the constraints of field sampling conditions, we recommend that AEA target its fish sampling to meet the following specific objectives: (1) a minimum of 10 tags per species be allocated for tagging adult grayling and rainbow trout of sufficient size for spawning at tributary mouths during the spring sampling event; (2) a minimum of 10 tags should be allocated for tagging adult Dolly Varden of sufficient size for spawning at tributary mouths during a late summer or early fall sampling event; (3) a minimum of 10 tags should be allocated for tagging adult whitefish prior to spawning in early September; and (4) a minimum of 10 tags should be allocated for tagging burbot in the early fall prior to fall or winter spawning migrations.

Radio Telemetry Monitoring

NMFS and FWS state that fixed telemetry stations must be operational year round to document the movement of target fish species. In addition, the agencies state that aerial telemetry surveys must be conducted weekly during May and September to document migration timing into spawning tributaries and to document burbot spawning locations.

Alaska DFG recommends dedicated aerial surveys once every two weeks or weekly during periods of suspected spawning activity, including humpback whitefish during early October, and burbot during late January/early February. Alaska DFG recommends that, at a minimum, sampling strategies for 2014 should be amended based on 2013 results.

Discussion and Staff Recommendation

AEA proposes to service its fixed telemetry stations from July through October. It also states that an unspecified subset of stations would be maintained through the winter months and that decisions on the stations would be made based on fish movements in the fall and environmental conditions. In addition, part of the 2013 winter pilot study would include attempts to determine the feasibility and accuracy of monitoring radio-tagged fish under ice. AEA does not indicate which fixed stations would be maintained during winter, or if any of those stations would be located in the Upper River study area. We estimate that the additional cost to maintain all fixed stations during the winter would be approximately $100,000 (section 5.9(b)(7)). Without winter data collected from at least a subset of fixed stations, it would not be possible to determine whether the fixed stations would provide any additional monitoring benefits to justify the additional cost.

AEA proposes to conduct aerial surveys weekly from July through October, and monthly November through June. This is slightly less effort than requested by NMFS and FWS, in that weekly flights are not proposed during the month of May. However, AEA's proposed spring surveys would still provide some data on fish movements and migratory behavior following initial ice-out. We estimate that the cost of conducting aerial surveys would be around $7,000 per week, assuming aerial surveys would take one day per survey, for a total cost of $22,000 for the three recommended additional surveys (section 5.9(b)(7)). AEA proposes an acceptable initial level of effort for evaluating migratory behavior of resident fish species in the Upper River study area (section 5.9(b)(7)). There are numerous provisions within the ILP prefiling study plan implementation process that allow for an evaluation of the effectiveness of AEA's initial study methods, and appropriate study modifications could be proposed by AEA or requested by the agencies, following the initial evaluation. The first of these opportunities occurs after the filing of the initial study report (sections 5.15(c)(2) and 5.15(c)(4)).

No modifications to the study plan are recommended

Otolith Sampling and Analysis

NMFS and FWS state that samples should be collected from 30 known anadromous Dolly Varden and 30 known non-anadromous Dolly Varden populations and analyzed. Similarly, NMFS and FWS state that otoliths should be collected from 30 known anadromous humpback whitefish and 30 known resident humpback whitefish populations. The agencies request that samples be analyzed for strontium and calcium and ratios of strontium to calcium calculated. The agencies state that anadromy should be determined through statistical comparisons of strontium and calcium ratios among these three samples: Upper River fish, known anadromous, and known resident fish of the same species.

Discussion and Staff Recommendation

AEA states in the RSP that otoliths would be collected from 30 Dolly Varden and 30 humpback whitefish in the Upper River in 2013 and 2014 (60 fish total for each species) over 200 mm in length and analyzed for unspecified marine elements indicative of anadromous life history. AEA provides a description of its methods for stable isotope analysis of tissue from the carcasses of spawned out salmon in the final Implementation Plan for Study 9.8 (river productivity). We do not know if these "tissue" samples are a reference to the otoliths collected, or if it is a different analysis. We presume that the otoliths collected for the Dolly Varden and whitefish populations would similarly be processed as described in the final Implementation Plan, although this is not explicitly stated. We reviewed the methods and conclude that AEA's proposed stable isotope analysis approach is consistent with generally accepted practices in the scientific community (section 5.9(b)(6)), and should provide the information necessary to evaluate anadromy under existing conditions.

No modifications to the study plan are recommended.

Additional Sampling Units

NMFS and FWS request that sampling for juvenile salmonids and juvenile resident fish should include one 200 meter x 1 meter meander edge and one 200 meter x 1 meter point bar habitat as defined by the agencies in their recommended habitat classification methodology.

Discussion and Staff Recommendation

AEA does not propose to stratify its mainstem habitat types to a level that would be necessary to capture these relatively fine-scale habitat features, nor does it propose to utilize a stratified sampling design for its Upper River sampling strategy. If these habitat features are represented throughout the main channel and side-channel habitat types that are systematically selected throughout the study area, then AEA's sampling approach could capture fish use of these habitat features. However, we are not aware of any information to suggest that this level of stratification would be necessary to adequately describe fish distribution and abundance in the Upper River (section 5.9(b)(5)).

No modifications to the study plan are recommended.

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

Applicant's Proposed Study

AEA proposes to conduct a study to describe 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. The study area is divided into two river segments: (1) Middle River segment from the proposed Watana dam site at RM 184 downstream to the three rivers confluence area at RM 98.5, and (2) Lower River segment from RM 98.5 to RM 28.3. The overarching goal of this study is to characterize the current distribution, relative abundance, run timing, 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, and Arctic lamprey, as well as freshwater rearing life stages of anadromous salmonids (fry and juveniles) in the Middle and Lower River.

The study objectives are described below.

1) Describe the seasonal distribution, relative abundance (as determined by CPUE, fish density, and counts) and fish habitat associations of juvenile anadromous salmonids, non-salmonid anadromous fishes, and resident fishes.

2) Describe seasonal movements of 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 within 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 (passive integrated transponder [PIT] and radio-tags).

3) Describe early life history, 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;

c. determining juvenile salmonid diurnal behavior by season; and

d. collecting baseline data to support the stranding and trapping study (i.e., part of Study 8.5, fish and aquatics instream flow).

4) Document winter movements and timing and location of spawning for burbot, humpback whitefish, and round whitefish.

5) Document the seasonal age class structure, growth, and condition of juvenile anadromous and resident fish by habitat type.

6) Document the seasonal distribution, relative abundance, and habitat associations of invasive species (northern pike).

7) Collect tissue samples from juvenile salmon and opportunistically from all resident and non-salmon anadromous fish to support Study 9.14 (fish genetics).

In addition to the study description provided in the RSP, AEA also filed a final Susitna River Fish Distribution and Abundance Implementation Plan (Implementation Plan) on March 1, 2013, that provides additional information on the sampling strategy, study site selection process, and field sampling procedures. Specifically, the final Implementation Plan provides: (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. Pertinent information from the RSP and Implementation Plan is included in the discussion of AEA's proposed study methods below.

Because of differences in stream channel characteristics, AEA proposes to implement different sampling strategies throughout the study area, as described below.

Middle River Sample Design and Study Site Selection

AEA proposes to select sampling units within the Middle River study area using a generalized random tessellation stratified (GRTS) sampling method (Stevens and Olsen, 2004). The GRTS sample design produces a spatially balanced random sample with design-based variance estimators. In addition, the GRTS sample design provides an over-sample of sample sites to accommodate field implementation issues (e.g., a location is not accessible or is too deep to be sampled and must be skipped). Each unit to be sampled is placed in random order so that the random order is preserved if a sample needs to be skipped.

In the Middle River, the GRTS design would be used to select study sites based on a habitat stratified sampling scheme nested within Middle River geomorphic reaches. However, because geomorphic reach length and channel complexity vary greatly, not all habitat types will be found within each geomorphic reach. Within each geomorphic reach, two strata were formed: (1) the combined focus areas within the reach; and 2) the remainder of the reach not contained in focus areas. Within each of these strata, the total length of habitat in main channel, split main channel, multiple split main channel, side channel, upland slough with beaver complexes, upland slough without beaver complexes, side slough with beaver complexes, and side slough without beaver complexes are represented by line segments from the habitat mapping. For sampling, these line segments for each habitat type were partitioned into 40-meter sampling units with spatial referencing. For the line habitats, the GRTS samples selected were the 40-meter sampling units. Tributaries (mouth to upper extent of project influence), tributary mouths, tributary plumes, and backwaters, have been GRTS sampled as point locations. For line and point sampling, three sampling units were selected for each habitat type within each stratum. When three or fewer sampling units exist within the sample stratum, they would all be selected for sampling. All of the selected sample sites within focus areas would be sampled for relative abundance. Outside of focus areas, all selected sites would be selected for fish distribution. One of the selected sites for each available habitat type would also be sampled for relative abundance.

For mainstem habitats where boat electrofishing would be employed as a capture method, the 40-meter sampling unit length would be extended by 200 meters total, including 100 meters sampled upstream of the selected 40-meter unit and 100-meter samples downstream. This extends the length of the sample unit to 240 meters for boat electrofishing only within mainstem habitats.

Sampling frequency would vary among seasons and sites, based on specific objectives. Generally, sampling would occur monthly at all sites for fish distribution and relative abundance surveys during the ice-free season. At focus areas, sampling would occur monthly year-round and biweekly after break-up through July 1 to characterize the movements of juvenile salmonids during critical transition periods from spawning to rearing habitats.

Middle River study results would be presented as follows: fish distribution would be presented as fish observation locations on maps, while relative abundance estimates (e.g., fish per unit area, CPUE) would be summarized by habitat type and sampling method with appropriate statistical confidence intervals for GRTS samples.

Lower River Sample Design and Study Site Selection

AEA proposes a systematic transect approach for selecting Lower River study sites, whereby fish sampling sites would be selected within habitat units encountered along a transect. Using a random start, transects would be equally spaced at 7.4-mile intervals for a total of ten transects. Because of the complex nature of the Lower River, many transects span multiple habitat types (e.g., main channel, side channel, upland slough, and side slough), and in these instances one habitat unit of each type encountered would be selected along each transect. Where multiple habitat units of the same type occur, units would be randomized and one selected. Fish distribution and abundance sampling would then be conducted along a 40-meter-length of the unit, starting at the downstream end. Where boat electrofishing would be employed, the sampling unit would be 240 meters with the selected 40-meter unit located in the center of the study site. If the randomly selected habitat unit is totally inaccessible to field crews, then a second randomly selected habitat unit would be sampled.

One transect within each geomorphic reach would be sampled for relative abundance, with the remaining transects sampled for distribution only (i.e., single pass sampling). The transect with the most identified habitat units would be selected for abundance sampling in each reach. Lower River sampling would be conducted at monthly intervals.

Lower River study results would be presented as follows: fish distribution results would be presented as fish observation locations on maps, while relative abundance estimates (e.g., fish per unit area, CPUE) would be summarized by mainstem habitat type and sampling method with appropriate statistical confidence intervals.

The Implementation Plan includes a summary of relevant fisheries studies in the Susitna River and an overview of the life-history needs for fish species known to occur in the Susitna River. The Implementation Plan and RSP propose specific sampling methods, which are summarized below.

Field Techniques for Fish Distribution and Relative Abundance Sampling

A combination of active and passive fish sampling techniques would be used to document fish distribution and abundance. Sampling gear types to be used include:

gillnets, beach seines, fyke nets, angling, trotlines, boat and backpack electrofishing, minnow traps, fishwheels, outmigrant traps, snorkeling, DIDSON sonar, and underwater video camera techniques. The techniques selected include those used by Alaska DF&G in the 1980s as well as more advanced technologies that are now available. Selected methods for each sample unit would vary based on habitat characteristics, season, and species/life histories of interest. Logistical and safety constraints inherent in fish sampling in a large river in northern latitudes would play a role in selecting appropriate techniques under various site conditions. Some survey methods may not be used in the mainstem river immediately upstream of hazards such as cascades and rapids. All fish sampling and handling techniques described within the Implementation Plan would be conducted under state and federal biological collection permits, as applicable. Limitations on the use of some methods during particular time periods or locations may affect the ability to make statistical comparisons among spatial and temporal strata.

Salmon Early Life History Movements

Early life-history studies would be conducted in select focus areas where movements between spawning and early life-stage rearing habitats are anticipated based on results of historic and recent studies. Five focus areas that meet these criteria have been identified for intensive study. During bi-weekly fish distribution sampling, sites for sampling would include three designated 40-meter long sampling units immediately downstream of a documented Chinook, chum, or coho salmon spawning area (these may be tributary mouths or side sloughs at some focus Area locations) and three 40-meter long rearing habitat sampling units. Rearing habitat sampling units would be generally stratified in side slough habitat to include upper slough, middle slough, and slough mouth areas where appropriate. Electrofishing, seining, fyke nets, and minnow traps would be the primary methods for collecting salmon during the early life stage. Snorkeling may also be used where appropriate. Stranding assessment and winter sampling efforts would utilize the same sampling locations but would be less frequent, approximately monthly instead of bi-weekly and for winter would be dependent on safe access and sampling methods (due to ice cover).

PIT Tagging

PIT tag antenna arrays with automated data logging would be used at selected side channel, side slough, tributary mouth, and upland slough sites to detect movement of tagged fish into or out of the site. A total of three stationary PIT tag interrogation systems are proposed in the Middle River, and one in the Lower River.[41] Potential locations were

[41] As described in Study 9.5 (upper river fish distribution), two additional PIT tag detection sites would be established in the Upper River study area.

evaluated based on a review of existing data on fish distribution and habitat, the anticipated physical conditions and debris load at potential sites, and logistics for deploying, retrieving, and maintaining the antennas. These include the following locations in the Middle River and Lower River: Indian River approximately 1 mile upstream from its confluence with the Susitna River (RM 138.6), Slough 8A (RM 125), and Whiskers Slough (RM 104). These sites were selected based on historic fish use data and in order to co-locate PIT arrays with focus areas and radio-telemetry arrays. In the Lower River, one stationary interrogation system is proposed for Montana Creek (RM 77) near its confluence with the Susitna River. Montana Creek was selected because it is one of the major salmon producing tributaries in the Lower River study area and provides habitat for a diversity of resident species.

The target species for PIT tagging are juvenile Chinook and coho salmon and the following resident fish species: rainbow trout, Dolly Varden, humpback whitefish, round whitefish, northern pike, Arctic lamprey, Arctic grayling, and burbot. The target number of fish for PIT tagging is 1,000 fish per species per PIT tag interrogation site.

Downstream Migrant Tagging

AEA proposes to deploy rotary screw traps in the Susitna River Basin during the 2013 and 2014 field seasons. Three traps would be deployed in the Middle River and one would be deployed in the Lower River.[42] To identify specific trap locations within each of these hydrologic segments, potential rotary screw trap locations were evaluated based on: (1) a review of existing data on fish distribution and habitat; (2) anticipated physical conditions and debris loads at potential sites; and (3) logistics for deploying, retrieving, and maintaining the traps.

In the Middle River, proposed trap locations include Indian River (RM 138.6) approximately one river mile upstream of the Susitna River confluence, the mainstem Susitna River at Curry Station (RM 120), and the mainstem Susitna River at Talkeetna Station (RM 103). The Indian River is a primary tributary to the Middle River and is heavily used by Chinook and coho salmon and a diversity of resident fish species. In addition, the lower Indian River near its confluence with the Susitna River has historically been a focus of Middle River sampling efforts. The two mainstem river sites were selected, because they offer good hydraulic conditions for outmigrant trap operation and are located downstream of important Middle River spawning tributaries including Portage Creek and Indian River. The site at Talkeetna Station has the added benefit of

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[42] As described in Study 9.5 (upper river fish distribution), two additional rotary screw taps would be deployed in the Upper River study area.

being associated with historic data from outmigrant trapping efforts in the 1980s (Roth et al. 1986). In 1985, inclined plane traps at Talkeetna Station had significantly higher catch rates on the west bank of the Susitna River than on the east bank (Roth et al. 1986); thus, the outmigrant trap for the 2013 and 2014 study would be located in a similar position. Lastly, each of the three proposed Middle River trapping locations would be located in close proximity to other proposed 2013 and 2014 field efforts; this co-locating of sites is expected to facilitate site accessibility, field logistics, safety, and effective trapping operations.

In the Lower River, the proposed trapping location is in Montana Creek (RM 77) near its confluence with the Susitna River. Montana Creek was selected because it is one of the major salmon producing tributaries in the Lower River study area and has a diverse resident fish assemblage. In addition, Montana Creek is suspected to have a population of non-native northern pike, and AEA proposes to attempt to tag and track pike at this location.

Flow conditions permitting, rotary screw traps would be fished on a cycle of a 48 hours on and 72 hours off throughout the ice-free period. Rotary screw traps would be checked at least once per day. Morning check (05:00-10:00) and evening (18:00-23:00) checks are preferred in order to determine if fish movement occurs primarily at night or during the day. During periods of migration or high flow, traps may need to be checked more often.

To produce reliable estimates of relative abundance from rotary screw trap field data, estimates of trap efficiency are needed. AEA proposes to use Peterson mark-recapture methods to conduct a series of trap efficiency experiments over the course of the sampling season. Trap efficiency is estimated as the proportion of marked fish appearing in a random sample and equates to the proportion of marked fish in the total population, provided that certain assumptions are met. The basic assumptions of the Peterson method that apply to trap efficiency estimates include: (1) the population is closed; (2) all fish have the same probability of capture in the first sample; (3) the second sample is either a simple random sample, or if the second sample is systematic, marked and unmarked fish mix randomly; (4) marking does not affect catchability; (5) fish do not lose their marks; and (6) all recaptured marks are recognized.

A stratified mark-recapture design would be implemented to estimate the relative abundance of downstream migrants over short discrete time periods (i.e., 7 days) in which trap efficiency is paired with a recapture period. If numbers are sufficient, a minimum of 100 fish representative of the day's catch would be marked and released weekly. If only a portion of the daily catch is to be used for efficiency trials, fish would be randomly selected, measured for length, marked, allowed to recover, and released during the time period of their migration (i.e., day or night). The release location of marked fish is to be located far enough upstream so that marked fish can evenly mix with unmarked fish moving downstream, yet not so far upstream as to cause an extracted period of migration of marked fish over multiple days and expose fish to predation. Based on recommendations by Volkhardt (2007) and Roper (1995) and estimated lengths of mesohabitat units, marked fish would be released 300 meters upstream of the trap location. Marked fish should be released evenly across the width of the river if feasible, or equally along each river bank in calm water. Fish holding time would be minimized to less than 48 hours.

Radio Telemetry

AEA proposes to use radio telemetry as a remote monitoring technique to obtain spatial and temporal distribution data for individual resident and non-salmonid anadromous species. Target species for this study component are: arctic grayling, burbot, Dolly Varden, humpback whitefish, lake trout, longnose sucker, northern pike, rainbow trout, and round whitefish. Fish locations and movements would be tracked using fixed-receiver stations and mobile tracking to record time and date stamped, radio-coded signals from tags implanted in fish.

AEA proposes to use Advanced Telemetry Systems (ATS) telemetry equipment to monitor fish species. AEA notes that use of ATS equipment directly constrains the potential options for tagging and monitoring. More specifically, the smallest ATS coded tag weighs 6 g and thus requires fish to weigh at least 200 g for safe application. For some species, such as Dolly Varden, only the largest individuals captured would be tagged based on the length–frequency distribution. It is likely that each of the nine target species would have a proportion of individuals that are too small to radio-tag.

To accomplish the goals of this study, four different sized radio tags would be used with expected operational lives ranging from 180 to 901 days. The ATS model 1810C, 1815C, 1820C, and 1830C tags have minimum tagging weights of 200, 233, 267, and 367 g, respectively. The tags would be programmed to operate in slow pulse mode with 12 pulses per minute in order to extend the operational life of the tags as much as possible. All tags would be equipped with a motion sensitive sensor to alert biologists when a tag has remained motionless for 24 consecutive hours. Based on the number of tags to be released, AEA anticipates that seven radio frequencies would be needed for this study.

Fish would be captured opportunistically during sampling events targeting adult fish and with directed effort using a variety of methods. Preference would be given to fish caught with more benign techniques that cause minimal harm and stress to fish.

Fishwheels targeting adult salmon (Study 9.7, salmon escapement) located in the Middle River near Curry (RM 120) and in lower Devils Canyon (~RM 150-151) may be used to opportunistically collect some target species. Other techniques including angling, electrofishing, fyke nets, hoop traps, trot lines, and seines would be used in coordination with fish distribution and abundance sampling efforts or to specifically target species and/or locations for tagging purposes.

Tags would be surgically implanted in 60 fish of sufficient body size (i.e., ≥200 grams) of each target species. For each species, 30 tags would be allocated to the Upper River, and 30 tags would be allocated to the combined Middle/Lower River. AEA anticipates post-tagging survival to be 80 – 100 percent based on previous radio telemetry studies.

AEA states that in some reaches of the Susitna River, certain species may not be available in large enough quantities to fulfill the tagging goals. If this occurs, the unused tags would be reallocated to species which are more numerous. Efforts would be made to tag fish in focus areas and at other sites where fish inventory activities would be implemented. Spatial and temporal distribution of tags within each river reach would be determined by the sampling schedule of Study 9.5 (upper river fish distribution) and Study 9.6 (middle and lower river fish distribution), and the availability of fish of each target species.

Radio-tagged fish would be tracked by detections at fixed receiver stations and aerial surveys. Fixed stations would include those used for Study 9.7 (salmon escapement), and five additional fixed stations would be established at strategic locations in the Middle/Lower River, and three additional stations would be added in the Upper River with input from the TWG. AEA proposes to service these stations in conjunction with Study 9.7 during the July through October period and during dedicated trips outside this period. Data from fixed-receiver stations would be downloaded as power and storage capacities necessitate and up to twice monthly during the salmon spawning period (approximately July through October). Study 9.7 would provide approximately weekly aerial survey coverage of the Middle/Lower River (approximately July through October) and coverage of the Upper River as salmon distribution dictates. At other times of the year, the frequency and location of aerial surveys would be monthly.

Fixed-station receiver sites for Study 9.7 would be operated at ten strategic locations in the Middle and Upper River including: Lane Creek Station (RM 113.0), Gateway (RM 125.5), Fourth of July Creek (RM 131.1), Indian River (RM 138.5), Slough 21 (RM 141.1), Portage Creek (RM 148.8), Cheechako Station (RM 152.4), the Chinook Creek confluence (RM 157.0), Devils Station (RM 164.0, located upstream of the Devils Creek confluence), and the Kosina Creek confluence (RM 206.8). The locations for the eight proposed resident fish stations, include: Montana Creek confluence (RM 77.0), Whiskers Creek confluence (RM 101), Indian River confluence (RM 138.6), Portage Creek confluence (RM 148.8), Fog Creek confluence (RM 176.7), Watana dam site (RM 184.0), Watana Creek confluence (RM 194.1), and Oshetna River confluence (RM 233.4). Both adult salmon and resident fish frequencies would be programmed on all radio telemetry receivers as appropriate in time and space.

Aerial surveys conducted for Study 9.7 (salmon escapement) would provide approximately weekly aerial survey coverage of the study area from approximately July to October and at least monthly during other periods. Using the guidance of fixed-station and aerial survey data on the known positions of tagged fish, specific locations of any concentrations of tagged fish that are suspected to be spawning would be visited to obtain individual fish positions. Aerial surveys targeting radio-tagged salmon would be conducted in the mainstem Susitna River from RM 22 to Kosina Creek (RM 206.8). If radiotagged fish are detected moving upstream in the mainstem at the Kosina Creek telemetry station, aerial surveys would be geographically extended to locate those radio tagged fish. In addition to aerial surveys, foot and boat surveys would be conducted from approximately July to October as part of Study 9.7. Spatial and temporal allocation of survey effort would be finalized based on the actual locations and numbers of tagged fish for each species. Aerial surveys to track radio-tagged resident fish would be conducted at least monthly from November to June between RM 61 and RM 230. The goal for helicopter-based surveys is to record a position within approximately 300 meters (1,000 feet) of a target tag, as well as to determine whether the fish is in off-channel or mainstem habitat. Forward and downward looking antennas would assist in determining tag locations effectively. At least four receivers would be used to minimize the number of frequencies scanned per unit. Geographic coordinates would be recorded for each detected signal using an integrated communication link between the telemetry receiver and a global positioning system (GPS) unit.

Mobile telemetry surveys may also be conducted by boat, snow machine, and foot to obtain the most accurate and highest resolution positions of fish. Using the guidance of fixed-station and aerial survey data on the known positions of tagged fish, specific locations of any concentrations of tagged fish that are suspected to be spawning can be visited to obtain individual fish positions. Spatial and temporal allocation of survey effort would be finalized based on the actual locations and numbers of tagged fish for each species. The channel location (mainstem, side channel, slough) and relative water turbidity at the location of the fish would be classified for each tag detected (time stamp, frequency, code, power level) during aerial surveys. If other fish can be seen in the area of the tag position, their relative abundance would be visually estimated to provide context for the tag observation. Tag identification, coordinates, and habitat type data would be archived and systematically processed after each survey. A data handling script would be used to extract unique tag records with the highest power level from the receiver files generated during the survey. These records would be imported into a custom database software application (Telemetry Manager) and incorporated into a (GIS) based mapping database. Geographically and temporally stratified data of radio-tagged fish would be provided to the habitat and instream flow study teams to inform their field sampling efforts.

Fish Tissue Sampling

Fish tissue samples for determining baseline metal and mercury concentrations would be collected during fish distribution and abundance surveys in the vicinity of proposed reservoir location. Given the opportunistic nature of the fish tissue sample collection, specific fish tissue sampling sites have not been preselected. However, the target sampling area includes the Upper River segment and its tributaries and is contained within the study area for Study 9.5 (upper river fish distribution).

Fish tissue samples for use in trophic analysis would be collected during fish distribution and abundance surveys conducted at two of the four Middle River focus areas selected for Study 9.8 (river productivity). The primary role of the fish distribution and abundance survey crew for this study is to provide captured fish to a trained field technician, who would be responsible for fish tissue sample collection. The field technician would be provided by the study team for Study 9.8. Fish tissue samples would be collected from adult salmon carcasses, as well as juvenile Chinook salmon, juvenile coho salmon, and juvenile and adult rainbow trout. To account for temporal variability in isotopic signatures, samples would be collected at the selected focus area sites during the spring, summer, and fall season.

Fish tissue samples for use in Study 9.14 (genetics) would be collected as part of fish distribution and abundance surveys and focused primarily on: (1) Pacific salmon spawning in the Upper River and Middle River segments, (2) juvenile Chinook salmon habitat use in the Lower River, and (3) resident and non-salmon anadromous species in the Upper River and Middle River segments. Specific details regarding target sample locations, species, life stages, and annual sample sizes for genetics analysis are provided in Study 9.14.

Fish Gut Content Sampling

Juvenile Chinook salmon, juvenile coho salmon, and juvenile and adult rainbow trout captured during the fish distribution and abundance studies in the Upper River and Middle River would be used for stomach content samples to support Study 9.8 (river productivity) objectives. Stomach content sampling would be performed by a trained field technician provided by the Study 9.8 study team. The technician would accompany fish survey crews to selected study sites, where planned fish distribution and abundance surveys would occur. In the Middle River, gut samples would be collected at the four Middle River focus areas selected for intensive study in Study 9.8. In the Upper River segment, stomach content sampling would be conducted on a more opportunistic basis. That is, initial fish distribution and abundance study findings may be used to increase the likelihood of encountering target species and life stages in the Upper River prior to the stomach sampling technician accompanying the fish survey crew in the field. However, the fish survey crew would adhere to the site selection and sampling designs for fish distribution and abundance sampling to avoid biased results and thus, would not actively target species for stomach content sampling.

Winter Sampling

AEA proposes to conduct a pilot study at the Whiskers Slough focus area (RM 101-102) during the winter of 2013. AEA states that Whiskers Slough was selected because: (1) it contains a diversity of habitat types, (2) because sampling in the 1980s and 2012 revealed the presence of spawning and rearing salmon and resident fishes (Schmidt et al. 1983), and (3) it is relatively accessible from Talkeetna. The pilot study would evaluate the effectiveness and feasibility of winter sampling methods including: underwater fish observations via DIDSON sonar and underwater video, minnow traps, seines, electrofishing, trotlines, PIT tags, and radio tags. The pilot study would also be used to evaluate the feasibility of sampling during spring break up; assess winter sampling logistics, including safety, sampling methods in different habitat types under varying degrees of ice cover, transportation and site access logistics, travel time, and winter-specific gear needs; and develop recommendations for subsequent winter studies beginning in the late fall of 2014. Ultimately, the objectives of the winter fish studies would be to: (1) document the distribution of juvenile salmonids and non-salmonid resident fish in winter; (2) describe seasonal movement, timing, and habitat use by juvenile salmonids at selected focus areas in winter; and (3) determine diurnal activity of juvenile salmonids at selected focus areas in winter.

Winter fish sampling would employ multiple methods to determine which are most effective for each fish species, lifestage, and habitat type. Because sampling efforts would occur at both open leads and ice covered sites, methods would vary depending on conditions. In ice-covered sites, the primary sampling methods would be trotlines and minnow traps. In open leads, fish capture methods would include baited minnow traps, electrofishing, and beach seines. Remote telemetry techniques would include radio telemetry and PIT tag technology. AEA states that both of these methods need to be tested for tag detectability under ice cover. All fish sampling would occur approximately monthly from February through April 2013 and would be coordinated with the intergravel temperature monitoring and the underwater fish observation components.

Relational Database

AEA proposes to develop a database template to store the fish distribution and abundance data from all consultants and studies, providing a centralized data tool for users. The final database would be maintained in Microsoft Access software and would include data collected in 2012 and new data from future studies in 2013 and 2014. The database would be available for querying and analysis by an unspecified number of entities that are as-yet unidentified by AEA.

A data dictionary describing the database entities and attributes would be compiled, to accompany the database and to provide an understanding of data elements and their use by anyone querying or analyzing the data.

Comments on the Study

Location of Focus Areas

NMFS and FWS state that many of the current proposed focus areas are distributed upstream of the geographic range of most fish species, and do not provide adequate replication of main channel, side channel, side slough, upland slough, and tributary mouth habitats that overlap with the likely distribution of juvenile anadromous and resident fish species. NMFS and FWS recommend that focus area 171 be moved to a site that includes 4th of July Creek and the sloughs upstream, and that focus area 151 be moved to a site in MR-7, possibly near Lower McKenzie Creek or below Curry on old Oxbow II. NMFS and FWS state that an additional focus area should be located in the physically dynamic MR-8 below Whiskers Creek and upstream of the three rivers confluence.

Discussion and Staff Recommendation

We evaluate the agencies' recommendations for the appropriate locations of Middle River focus areas in our analysis and recommendations for Study 8.5 (fish and aquatics instream flow).

No modifications to the study plan are recommended.

Middle and Lower River Mainstem Sample Unit Length

NMFS and FWS state that 40-meter sampling units are too small for all mainstem habitat classes. NMFS and FWS state that sampling units should be proportional to channel or off-channel habitat width. NMFS and FWS recommend that for main channel and side channel macrohabitats, sampling units should be 500 to 1,000 meters in length or the entire length of the side channel, and should be sampled with boat electrofishing. In addition, the agencies state that tributary mouths should include the backwater confluence with the mainstem and extend a minimum of 200 meters downstream, and side slough and upland slough sampling units should include the mainstem backwater confluence and extend a minimum of 200 to 300 meters up the slough.

Discussion and Staff Recommendation

AEA does not appear to provide any scientific basis for its proposed 40-meter subsample length in off-channel sampling locations, or its proposed 240-meter subsample lengths in main channel boat electrofishing sampling locations, and there is no information in the study plan or scientific literature to reasonably conclude that this would be an acceptable approach to capture fish distribution and abundance within these very large, main channel and off-channel macrohabitats, some of which would likely be greater than 1,000 meters in length (section 5.9(b)(6)). AEA's proposed methods for subsampling habitat units in 40-meter or 240-meter increments, would likely result in a biased characterization of fish distribution and abundance because it would be directly related to whether the small subsample that is selected happens to be an area of particularly high or low fish density within a much larger habitat unit. Because its proposed methods would result in sampling relatively few habitat units and extrapolating these to a large geographic area, the bias is likely to have substantial implications for accurately characterizing the existing environment for fisheries resources of the project area and conducting the required analysis of project effects (section 5.9(b)(5)). Instead, an accepted approach as recommended by NMFS and FWS, would be to implement a sampling unit length for all main channel and side channel macrohabitats that is proportional to the channel width of the habitat unit (e.g., 20 times the wetted width), or the entire length of habitat unit, or 500 meters, whichever is less (section 5.9(b)(6)).

For side slough and upland slough habitats, a sample unit length of 200 meters or the entire slough, whichever is less, as recommended by the agencies would likely be adequate to capture habitat (and fish density) variability within slough habitats. Sampling the entire slough or 200 meters, whichever is less, as recommended by NMFS and FWS, is both consistent with accepted practices (section 5.9(b)(6)) and should be a reasonable level of effort to meet the study objectives. In addition, the agencies' request that AEA initiate sampling at the lowest end of all sloughs where they connect to the mainstem (and backwaters are formed) appears to be based on the agencies' site-specific knowledge that these areas provide a disproportionate level of use by target species, and if not included, could result in the under-representation (or omission) of one or more target species. Sampling up to 200 meters, or the entire slough length, should adequately represent habitat conditions in the remaining length of sloughs. Similar to our analysis regarding the appropriate sampling unit length for main channel and off-channel habitats, sampling 40-meter lengths at tributary mouths appears to be an inadequate level of effort that does not appear to be based on any scientifically accepted practices (section 5.9(b)(6)). Instead, a reasonable approach, as recommended by the agencies, would be to extend sampling to include the backwater area within the tributary, if present, and a distance 200 meters downstream of the tributary mouth/confluence with the mainstem.

In regard to expanding the sampling unit length in all habitat types discussed above, we estimate that the majority of the cost incurred in fish sampling would be associated with the logistical effort of getting a crew and equipment to a sampling site, and that the incremental cost of increasing the area of sampling to the entire length of the habitat unit, or a length proportional to the wetted channel width and capped at either 200 meters (for sloughs) or 500 meters (for main channel and side channel units), or whichever is less, as appropriate, would be relatively low in comparison (section 5.9(b)(7)). This would especially be the case for boat electrofishing methods which may require more effort to set up than would actually be required to conduct the sampling.

We recommend that sampling unit lengths for all main channel and side channel habitat units be equal to 20 times the wetted channel width of the habitat unit, the entire length of the habitat unit, or 500 meters, whichever is less.

We recommend that sampling unit lengths for all slough macrohabitats encompass the entire length of the slough, a distance equal to 20 times the wetted channel width of the slough, or 200 meters, whichever is less. We also recommend that slough sampling be initiated at the downstream end of the slough.

We recommend that, to the extent possible based on site-specific field conditions, AEA sample all main channel and side channel macrohabitat units with boat electrofishing methods.

We recommend that AEA's proposed tributary mouth sampling unit lengths include the backwater area within the tributary, if present, and extend a distance 200 meters downstream of the tributary mouth/confluence with the mainstem.

Additional Sampling Units

NMFS and FWS request that sampling for juvenile salmonids and juvenile resident fish include one 200 meter x 1 meter meander edge and one 200 meter x 1 meter point bar habitat as defined by the agencies in their recommended habitat classification methodology.

Discussion and Staff Recommendation

AEA does not propose to stratify its mainstem habitat types to a level that would be necessary to capture these relatively fine-scale habitat features. If these habitat features are represented throughout the main channel and side-channel habitat types that are randomly selected throughout the study area, then AEA's sampling approach could capture fish use of these habitat features. However, we are not aware of any information to suggest that this level of stratification would be necessary to adequately describe fish distribution and abundance in the Middle River or Lower River study areas (section 5.9(b)(5)).

No modifications to the study plan are recommended.

Reduce Classification of Mainstem Habitat Types

NMFS and FWS state that the inclusion of split channel and multiple split channel as two distinct mainstem macrohabitat types does not identify areas of unique physical or chemical characteristics between the two channel types. The agencies state that adding these additional mainstem classes doubles the number of main channel habitats to be sampled making adequate replication more expensive without providing any gain of useful additional information. In addition, NMFS and FWS state that the classification of backwaters and tributary plumes at the same hierarchical level as side sloughs and upland sloughs also results in too many sites for replication. Overall, NMFS and FWS contend that sampling locations must replicate the macrohabitat types as identified and agreed upon during the TWG meetings, and used in the 1980s studies and in PSPs. NMFS and FWS note that using these agreed upon macrohabitats would decrease the number of habitat types to be sampled from 10, or more, as proposed by AEA (depending on within or outside of a focus area) to 5.

In addition, NMFS and FWS state that three replicates is not generally an accepted practice in the scientific community to determine fish habitat relationships, and suggest that six is generally accepted as the minimum number of replicates to achieve acceptable levels of statistical power.

Discussion and Staff Recommendation

We evaluate the river stratification and habitat classification system for all aquatic studies, including the classification of backwater and tributary plumes within the appropriate hierarchical level, in our analysis and recommendations for Study 9.9 (aquatic habitat mapping).

AEA's proposed nested stratified sampling scheme using the GRTS method for sample site selection would provide a non-biased representation of the habitat within the study area and is an accepted practice for evaluating fish distribution and abundance by habitat type within each of the geomorphic reaches included in the study area (section 5.9(b)(6)). This habitat-based approach to sampling should be effective at documenting fish distribution patterns under existing conditions and would provide a basis for evaluating project effects (section 5.9(b)(5)).

No modifications to the study plan are recommended.

Lower River Sampling Locations

NMFS and FWS state that the selection of 10 Lower River sampling sites by systematically selecting a transect location every 7.4 miles is an ineffective method of site selection and would not provide sufficient sampling replication of Lower River macrohabitats or adequately address potential project effects.

NMFS and FWS recommend conducting sampling at 6 tributary and randomly selecting 6 side sloughs and 6 upland sloughs in areas adjacent to these tributary and mainstem sampling locations.

Discussion and Staff Recommendation

Due to the channel morphology in the Lower River, AEA's proposed approach is a reasonable and accepted sampling design for sampling the complex habitat conditions of the Lower River and should provide sufficient information on fish distribution and relative abundance in a reach where very little information on juvenile Pacific salmon, and various life stages of other resident fish species is currently available.

No modifications to the study plan are recommended.

Timing of Sampling

NMFS and FWS recommend initiating sampling in the spring following ice out (mid to late May) when fish are already moving between habitats; sampling to document summer rearing distribution and habitat associations during early to mid-July and mid-August to September; Autumn sampling period should be late September to early October.

Discussion and Staff Recommendation

AEA's proposal to sample seasonally with more frequent bi-weekly sampling immediately following ice-out to capture critical juvenile outmigration from natal tributaries appears to accommodate the agencies' request that AEA sample in the spring as soon as ice–out occurs.

In regard to summer sampling, AEA states in its Implementation Plan that fish distribution and abundance sampling would occur every other month from May through October. If sampling were to occur in May, July, and either late August or early September, which is certainly possible based on AEA's proposed sampling frequency, the proposed approach would be compatible with the NMFS and FWS' requested sampling periods. It's not entirely clear when sampling would occur, but AEA's approach as slightly modified by the agencies' request should not result in any additional effort or costs (section 5.9(b)(7)), and would be appropriate to characterize summer rearing conditions.

As with summer sampling, if autumn sampling were to occur in late September to early October, which is certainly possible based on AEA's proposed sampling frequency, the proposed approach would be compatible with the NMFS and FWS' requested sampling periods.

We recommend that the proposed summer sampling events be conducted in mid-July, and again in either late August or early September. We recommend that the proposed autumn sampling occur in late September to early October.

Catch Per Unit Effort from Electrofishing Macrohabitats

NMFS and FWS state that fish sampling should provide catch per unit effort (CPUE) from electrofishing (boat or back pack) for each mainstem macrohabitat (main channel, side channel, side slough, upland slough, and tributary mouth) and for each tributary mesohabitat categories.

NMFS and FWS state that CPUE information should be collected (e.g., catch per unit of time electrofishing) for both distribution and abundance sampling efforts. The agencies state that using CPUE from the first pass of the abundance collections and the single pass distribution CPUE would allow for direct comparisons among distribution and abundance sample sites.

NMFS and FWS state that fish sampling should provide catch per unit trap from minnow trapping (using 20 traps per 200 meter sampling reach soaked for 24 hours) for each mainstem macrohabitat (main channel, side channel, side slough, upland slough, and tributary mouth) and for each tributary mesohabitat categories. NMFS and FWS add that minnow traps should not be placed haphazardly within a sampling reach, but in locations most likely to capture fish (e.g., areas with cover) or that fish can occupy for extended periods of time (e.g., where water velocity is less than sustained swimming speeds of target fish).

Discussion and Staff Recommendation

In section 8.2 of the final Implementation Plan, AEA proposes to record fish capture data and sampling effort (i.e., electrofishing “power on” recorded in seconds) for both backpack and boat electrofishing separately so that CPUE can be calculated within each sample unit. This is consistent with the NMFS and FWS request, and is scientifically accepted practice (section 5.9(b)(6)). NMFS and FWS note that CPUE from multiple pass electrofishing is inaccurate, and that accurate and comparable CPUE data should only be based on the first pass. Although AEA is not clear on how CPUE from electrofishing would be calculated, we agree with the agencies’ concerns. We note, however, that AEA is likely already factoring this into its analytical approaches, even though it’s not explicitly stated in the RSP.

AEA has proposed to set 4–8 traps “haphazardly” for three hours for “distribution” sampling and 4–8 traps with three 90-minute soak periods for “abundance” sampling. Although the proposed three-hour soak time for distribution surveys is slightly higher than the 90-minutes NMFS and FWS responded to, there does appear to be potential problems with the proposed approach. We agree that the alternative proposed by NMFS and FWS using a 24-soak would likely result in better representation of fish distribution. Either trap density would probably be sufficient provided that the soak time is longer. We also agree that the use of minnow traps for abundance sampling is problematic, and not a generally accepted scientific practice (section 5.9(b)(6)). In addition, we agree with NMFS and FWS that there is general scientific consensus that minnow traps are more effective when placed in areas with cover and low water velocity, rather than placed haphazardly within a habitat unit.

AEA proposes that all methods would be conducted consistent with generating estimates of CPUE that are meaningful and facilitate comparison of counts or densities of fish over space and time. We agree with the agencies that it is not entirely clear how

AEA would analyze and report CPUE data. However, AEA's proposed sampling approach should provide the information necessary to properly describe CPUE, and we envision that in initial and updated study reports AEA would clearly describe analytical methods.

We recommend that calculation of CPUE from electrofishing data be based only on the first pass, as requested by NMFS and FWS.

We recommend that minnow traps be soaked for 24 hours and placed within locations most likely to capture fish (e.g., low-velocity habitat in close proximity to cover).

Length Frequency and Condition Factor

NMFS and FWS state that fish sampling should provide length frequency distribution for each species for each sampling date and macrohabitat using combined data from electrofishing and minnow trapping and lengths of all captured fish.

NMFS and FWS state that fish sampling should also provide condition factor (length/weight^3 x 10,000) for all species on all sampling dates from weights of first 50 fish of each species at each sampling location.

Discussion and Staff Recommendation

AEA is already proposing to measure the fork length and weight of all captured fish during Upper River sampling. Therefore, the length frequency data would be available to summarize by species, sampling date, macrohabitat, and capture technique, as requested by NMFS and FWS. AEA also proposes to determine the condition factor for captured fish within each habitat type. It appears that these proposed methods and level of effort (section 5.9(b)(7)) are consistent with the agencies' request, and the methods are scientifically accepted practices (section 5.9(b)(6)) for collecting the data necessary to calculate length frequency distributions and condition factor for sampled fish.

No modifications to the study plan are recommended.

Habitat Characteristics

NMFS and FWS request that within each 500 to 1,000 meter main channel and side channel sampling unit, and within each 200 to 300 meter side slough, upland slough, and tributary mouth a number of habitat characteristics be measured, including woody debris, pebble counts, wetted channel width, bank vegetation, and cover.

Discussion and Staff Recommendation

The agencies provide no specific information to support why this additional data would be needed (section 5.9(b)(4)), how it would be applied to the fish distribution and abundance study results, or what the level of effort and cost would be to collect the additional data (section 5.9(b)(7)). For these reasons, we have insufficient justification to recommend that AEA collect additional data to accommodate the agencies request.

No modifications to the study plan are recommended.

Release of Tagged Fish

NMFS and FWS state that fish captured in the outmigrant trap in Indian River and Montana Creek and PIT tagged should not be released upstream of the tagging array as these fish would bias the analyses toward those fish already migrating downstream.

Discussion and Staff Recommendation

Since each PIT tagged fish has a unique identification code, any fish released upstream of an array could be accounted for in the database for future analysis at relatively low cost.

No modifications to the study plan are recommended.

Growth Rate Analysis of PIT tagged fish

NMFS and FWS state that all PIT tagged fish should be weighed before and after tag placement so that growth rates based on change in weight can be calculated.

Discussion and Staff Recommendation

AEA is proposing to measure the length and weight of all captured fish to provide information on changes in length and weight (growth). Change in length and change in mass are both accepted practices in the scientific community (section 5.9(b)(6)). The NMFS and FWS concern regarding the weight of PIT tags could be addressed by either weighing fish after the PIT tag is inserted, or subtracting the weight of PIT tags after data is processed.

No modifications to the study plan are recommended.

PIT Tag Antenna Array at Whiskers Creek

NMFS and FWS state that the stationary array in Whiskers Creek should be placed downstream of the confluence of the side slough and Whiskers Creek, or at the mouth of Whiskers Creek, to document fish movement into and out of Whiskers Creek and out of the side slough. This would allow fish use in Whiskers Creek to be monitored, as well as in Whiskers Slough.

Discussion and Staff Recommendation

AEA proposes to install a PIT tagging array site at an unspecified location in Whiskers Slough where there appears to be a tributary mouth, upland slough, and side slough in proximity to Whiskers Creek. Apparently, the downstream end of the side slough at Whiskers Creek discharges into the mouth of Whiskers Creek, rather than into the Susitna River. Although many factors affect array site location, including channel width, channel depth, and access, NMFS and FWS present good rational for locating the array downstream of the confluence of the side slough and Whiskers Creek, or at the mouth of Whiskers Creek.

We recommend that, if feasible given site-specific conditions, AEA locate the PIT tag array downstream of the confluence of the side slough and Whiskers Creek, or at the mouth of Whiskers Creek. Should these locations not be feasible for deployment, AEA should consult with the TWG and select an appropriate location for the PIT tag array at Whiskers Slough.

PIT Tag Antenna Array in Slough 8A

NMFS and FWS state that the stationary array in Slough 8A should be moved to the 6A tributary mouth or another low sloped wetland stream (Lower McKenzie, Trapper Creek) to provide a replicate measure of resident and anadromous fish use of these similar tributaries. Slough 8A would provide only one measure of one side slough which is not comparable to the side slough at Whiskers Creek and may or may not be representative of this habitat type.

Discussion and Staff Recommendation

Many factors would affect the siting of the PIT tag array, including channel width, channel depth, access, and the PIT tag array’s relationship with the other study goals, data needs, and objectives. We have insufficient information to determine whether one site would be any better than the other, or which site would be the most desirable for meeting the study objectives for this study or any other study. It appears as though there would be no cost to move the PIT tag array location from Slough 8A to one of the agencies requested locations (section 5.9(b)(7)). We are not opposed to AEA moving the proposed PIT tag location at Slough 8A should it elect to do so in consultation with the TWG prior to the start of the study season. If that is the case, the selected location should be documented in the Initial Study Report.

No modifications to the study plan are recommended.

Fish Capture for PIT Tagging

NMFS and FWS state that five 400-meter long fish sampling locations should be located in Indian River and stratified longitudinally from the PIT tag array site to the farthest upstream Alaska Railroad crossing. The agencies state that five 400-meter fish sampling locations should be located in Montana Creek from the Parks Highway extending upstream to Yoder Road. The agencies request that five 200-meter long fish sampling locations should be established in Whiskers Creek at 1,000 meter intervals extending upstream from the Susitna River confluence. The agencies recommend that fish sampling be conducted in these locations using a combination of electrofishing and minnow trapping as described previously to capture juvenile coho and Chinook salmon for PIT tagging.

Discussion and Staff Recommendation

AEA proposes to tag up to 1,000 each of Chinook salmon, coho salmon, rainbow trout, Dolly Varden, round whitefish, humpback whitefish, northern pike, lamprey, grayling, and burbot per PIT tag array site. Fish for PIT tagging would be captured opportunistically during fish distribution and abundance sampling. Thus, a suite of capture methods would be employed including: gill nets/set nets, electrofishing, angling, trotlines, minnow traps, fyke nets, hoop traps, beach seines, fishwheels, and outmigrant traps. In addition, arrays located at Indian River, Slough 8A, and Whiskers Creek/Slough are located near or within focus area sites where increased effort would be directed towards tagging fish. The approach to tagging fish proposed by AEA is fairly comprehensive and consistent with scientifically accepted practices (section 5.9(b)(6)). It's not clear why the additional specified sampling strategy recommended by the agencies would be needed to meet the study objectives (section 5.9(b)(4)).

No modifications to the study plan are recommended.

Montana Creek Outmigrant Trap

NMFS and FWS state that there may be a conflict with the sport fishery in Montana Creek, and recommend that the location of the Montana Creek outmigrant trap be held in reserve with the final location selected in consultation with the TWG.

<u>Discussion and Staff Recommendation</u>

There are numerous instances where screw traps and sport fishers coexist throughout the Pacific Northwest, and we are not aware of any sport fishery interests that would prevent the monitoring of a rotary screw trap. However, there are many suitable locations for rotary screw traps within the study area, and we are not opposed to AEA moving the proposed screw trap location at Montana Creek should it elect to do so in consultation with the TWG prior to the start of the study season. If that is the case, the selected location should be documented in the Initial Study Report.

No modifications to the study plan are recommended.

Radio Tagging of Resident Fish

NMFS and FWS state that adult grayling, rainbow trout, and Dolly Varden should be collected for tagging at tributary mouth sampling locations during the seasons immediately prior to their spawning migrations (i.e., early spring for grayling and rainbow trout, and early fall for Dolly Varden). The agencies contend that tagging should target larger fish, particularly those displaying spawning color or morphological changes. The agencies also recommend tagging adult whitefish prior to spawning migrations in early September, and burbot tagging should be conducted prior to fall or winter spawning migrations.

<u>Discussion and Staff Recommendation</u>

AEA proposes to opportunistically capture adult resident fish during other adult fish studies, as well as with directed efforts specifically targeting fish for radio tagging pursuant to this study using a variety of methods. AEA states that up to 10 tags per species would be implanted in fish captured at tributary mouths; however, it does not specify the target timing or location for capture of each species of adult resident fish for radio-telemetry, other than noting that fish sampling would occur during spring, summer, and fall. It is possible that AEA could collect enough fish during its proposed sampling framework to target the species, locations, and seasons specified by NMFS and FWS for radio-tagging adult resident fish, and we agree with NMFS and FWS that targeting specific locations and times for tagging adult resident fish would increase the likelihood of documenting spawning migration timing and spawning locations, which would facilitate a better understanding of potential project effects (section 5.9(b)(5)). Provided that tagging is attempted and successfully completed within the sampling framework already specified by AEA, there should be no additional costs to incorporate the agencies' specific recommendations (section 5.9(b)(7)).

To the extent possible given the constraints of field sampling conditions, we recommend that AEA target its fish sampling to meet the following specific objectives: (1) a minimum of 10 tags per species be allocated for tagging adult grayling and rainbow trout of sufficient size for spawning at tributary mouths during the spring sampling event; (2) a minimum of 10 tags be allocated for tagging adult Dolly Varden of sufficient size for spawning at tributary mouths during a late summer or early fall sampling event; (3) a minimum of 10 tags be allocated for tagging adult whitefish prior to spawning in early September; and (4) a minimum of 10 tags be allocated for tagging burbot in the early fall prior to fall or winter spawning migrations.

Radio Telemetry Monitoring

NMFS and FWS state that fixed telemetry stations must be operational year round to document the movement of target fish species. In addition, the agencies state that aerial telemetry surveys must be conducted weekly during May and September to document migration timing into spawning tributaries and to document burbot spawning locations.

Alaska DFG recommends dedicated aerial surveys once every two weeks or weekly during periods of suspected spawning activity, including humpback whitefish during early October, and burbot during late January/early February. Alaska DFG recommends that, at a minimum, sampling strategies for 2014 be amended based on 2013 results.

Discussion and Staff Recommendation

AEA proposes to service its fixed telemetry stations from July through October. It also states that an unspecified subset of stations would be maintained through the winter months and that decisions on the stations would be made based on fish movements in the fall and environmental conditions. In addition, part of the 2013 winter pilot study would include attempts to determine the feasibility and accuracy of monitoring radio-tagged fish under ice. AEA does not indicate which fixed stations would be maintained during winter, or if any of those stations would be located in the Middle River or Lower River study area. We estimate that the additional cost to maintain all fixed stations during the winter would be approximately $100,000 (section 5.9(b)(7)). Without winter data collected from at least a subset of fixed stations, it would not be possible to determine whether the fixed stations would provide any additional monitoring benefits to justify the additional cost.

AEA proposes to conduct aerial surveys weekly from July through October, and monthly November through June. This is slightly less effort than requested by NMFS and FWS, in that weekly flights are not proposed during the month of May. However, AEA's proposed spring surveys would still provide some data on fish movements and migratory behavior following initial ice-out. We estimate that the cost of conducting aerial surveys would be around $7,000 per week, assuming aerial surveys would take one day per survey, for a total cost of $22,000 for the three recommended additional surveys (section 5.9(b)(7)). AEA proposes an acceptable initial level of effort for evaluating migratory behavior of resident fish species in the Upper River study area (section 5.9(b)(7)). There are numerous provisions within the ILP pre-filing study plan implementation process that allow for an evaluation of the effectiveness of AEA's initial study methods, and appropriate study modifications could be proposed by AEA or requested by the agencies, following the initial evaluation. The first of these opportunities occurs after the filing of the initial study report (sections 5.15(c)(2) and 5.15(c)(4)).

No modifications to the study plan are recommended

Radio Telemetry Station in Lower River

NMFS and FWS state that fixed telemetry stations should be located in the Lower River to track the movement of resident fish species. NMFS and FWS state that this is of particular importance for tracking northern pike which are distributed among the low-sloped wetland tributaries of the Susitna River.

Discussion and Staff Recommendation

AEA proposes to install one fixed telemetry stations at Montana Creek, which is located at RM 77 within the Lower River segment. Although no stationary antennas are proposed for the lower 77 miles of the Susitna River, AEA proposes to track radio-tagged fish using aerial surveys weekly from July through October, and monthly from November through June. The overall radio telemetry approach is consistent with scientifically accepted practices (section 5.9(b)(6)), and the relatively high level of effort needed to implement weekly and monthly aerial surveys (depending on the season) (section 5.9(b)(7)) should provide sufficient information to document migratory behavior and habitat use of resident fish species within the Lower River segment.

No modifications to the study plan are recommended.

Winter Sampling

NMFS and FWS comment that the proposed study does not describe the metrics or analytical approach to determine fish-habitat associations during winter, does not outline differences in habitat quality and winter growth among macrohabitats, does not describe how characteristics that drive fish distribution among winter habitats would be determined, and does not demonstrate how the proposed project could affect fish overwintering habitat. In addition, NMFS and FWS make several specific recommendations for a winter sampling approach, including:

- Intensive winter fish sampling should occur at a minimum of 6 replicate tributary mouths, main channel or side channel backwaters, side sloughs, and upland slough habitats.

- Locating winter sampling within focus areas would allow for variability in fish metrics for species and life stage to be evaluated relative to differences in groundwater discharge, water temperatures, modeled water depths and velocities, and other habitat variables being measured at those locations.

- Sites could be on the left bank, accessible from the Alaska Railroad, reducing the need to travel by snow machine or helicopter. These sites would include currently proposed focus areas on Indian River, Gold Creek, Slough 8A, and added sites on Slough 9, downstream from Sherman, and Lane Creek.

- For additional sampling, sites could be selected in the Lower River at locations accessible from the Parks Highway. These could include Sunshine Creek and Birch Creek slough, Rabideux Creek, Montana Creek, Sheep Creek slough, Kashwitna River, and Deshka Landing, all of these stream locations provide access to the Susitna River sloughs and side channels.

- Sampling should be conducted monthly, November through March at each sampling location.

- Fish samples should be collected using 10 baited minnow traps that can be placed through holes cut through the ice for each 100 meter sampling area and fished for 24 hours. Results should be reported as catch per unit trap. All fish should be identified to species and fork length measured. Condition factors should be calculated from length-weight relationships and weights from the first 50 fish captured on each sampling date. Fish should be marked (fin clip, tattoos, or PIT tags) and used for mark recapture population estimates and to determine site fidelity.

- Video surveys should be conducted during the day and at night at all sampling locations as proposed to determine diurnal behavior patterns.

- Water depth, water temperature, water velocity, dominant substrate, dissolved oxygen, pH, specific conductivity, woody debris, and ice depth should be measured at multiple trap locations on each sampling date.

- Statistical tests should be conducted to determine if there are differences in fish species catch per trap, community composition, among macrohabitats and relationships between fish metrics and habitat variables.

Discussion and Staff Recommendation

AEA's proposed initial study efforts for documenting winter fish use are limited to a pilot study to be implemented in the winter of 2013, with additional winter efforts to be determined in the fall of 2013 in consultation with the TWG based on the results of the pilot study. Due to the challenging and potentially dangerous field conditions that are present in the Susitna River Basin during the winter, AEA's phased approach is reasonable in the circumstances of this case, and the proposed pilot study sampling methods appear to be consistent with scientifically accepted practices for winter sampling under ice conditions (section 5.9(b)(6)). There would be additional opportunities throughout ILP pre-filing study implementation to evaluate the effectiveness of winter sampling methods and, if found to be effective, apply additional winter sampling efforts throughout the study area. These include the fall of 2013 as proposed by AEA, and in response to information contained in the Initial and Updated Study Reports (sections 5.15(c)(2) and 5.15(c)(4)).

No modification to the study plan are recommended.

Emergent Salmonid Migration

NMFS and FWS state that the proposed sampling plan to document the distribution of emergent Chinook, coho, and sockeye salmon from spawning to rearing locations is inadequate and would not provide the necessary information to evaluate project effects. NMFS and FWS state that sampling locations must be selected at potential rearing habitats upstream and downstream from spawning sites and not within spawning sites. NMFS and FWS have specific recommendations for the emergent salmonid migration study, including:

- Select one sampling station at the backwater habitat at the downstream end of Slough 11, and 5 sampling locations at the backwater mouths of side sloughs and upland sloughs on river left spaced evenly downstream between Slough 11 and the upstream end of Slough 8A. A second set of sampling stations should include 1 site at the backwater downstream outlet of Slough 8A, with 5 sampling stations selected at the backwater mouths of side sloughs and upland slough on river left and spaced evenly downstream from Slough 8A to the three rivers confluence (12 sites). Three additional sampling locations should be selected at the mouth of Whiskers Creek, the tributary mouth referred to as Slough 6A, and the mouth of the Side Slough on river right upstream from 4th of July Creek.

- At each sampling location and on each sampling date, fish sampling should be conducted using a combination of 1 fyke/hoop traps (for sockeye, chum, and pink salmon) and 10 minnow traps (for Chinook and coho). Both fyke traps and minnow traps must have a maximum mesh size of <1/8 inch in order to retain small juvenile salmon. Fyke and minnow traps should be fished for 20 to 24 hours on each sampling date. Fyke traps are intended to capture sockeye fry schooling through these still water habitats and minnow traps are intended to capture Chinook and coho fry attracted to salmon eggs.

- Weekly sampling should continue until 90 percent of the cumulative frequency distribution of age-0 fish lengths is greater than 50 mm. This will provide a time period that can be used to determine when these small fish are most susceptible to project effects.

Discussion and Staff Recommendation

AEA proposes early life history studies that would take place in five select focus areas where movements between spawning and early life stage rearing habitats are anticipated based on results of historic and recent studies. During bi-weekly fish distribution sampling, sites for sampling would include three designated 40-meter long sampling units immediately downstream of a documented Chinook, chum, or coho salmon spawning area (these may be tributary mouths or side sloughs at some focus area locations) and three 40-meter long rearing habitat sampling units. Rearing habitat sampling units would be generally stratified in side slough habitat to include upper slough, middle slough, and slough mouth areas where appropriate. Electrofishing, seining, fyke nets, and minnow traps would be the primary methods for collecting salmon during the early life stage. Snorkeling may also be used where appropriate. Stranding assessment and winter sampling efforts would utilize the same sampling locations but would be less frequent, approximately monthly instead of biweekly and for winter would be dependent on safe access and sampling methods (due to ice cover).

AEA's proposed approach is consistent with scientifically accepted practices (section 5.9(b)(6)) and is a reasonable initial level of effort to address the study objectives (section 5.9(b)(7)).

No modification to the study plan are recommended.

River Productivity (9.8)

Applicant's Proposed Study

AEA proposes to conduct a study to evaluate the effects of project-induced changes in flow and interrelated environmental factors (temperature, substrate, water quality) upon the benthic macroinvertebrate and algal communities in the Susitna River.

Sampling for the study would be stratified by river segment and macrohabitat type.[43] Sampling would occur at seven study stations[44] on the Susitna River, and one station on the Talkeetna River. An additional Susitna River study station would be sampled during storm events only. Each station would have three sampling sites (one main channel macrohabitat and two different off-channel macrohabitats associated with the main channel macrohabitat), for a total of 24 sites on the Susitna River.

In the Upper River segment upstream of the proposed dam site at RM 184, two study stations would be located above the proposed dam and reservoir area (upstream of RM 223).

In the Middle River segment between the proposed dam site at RM 184 and the three rivers confluence area at RM 98.5, two study stations would be located between the

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[43] AEA classifies two main channel macrohabitat types ("main channel, single" and "main channel, split") and five off-channel macrohabitat types ("side channel," "tributary mouth," "side slough," "upland slough," and "beaver complex"). However, sampling for the river productivity studies is not proposed in beaver complexes.

[44] The proposed study stations in the Middle River segment are located at focus areas. Those in the Upper River and Lower River segments are stations proposed for river productivity sampling only and, as such, are not considered focus areas. Each contains multiple macrohabitats, which are also referred to as "sample sites."

dam site and the upper end of Devils Canyon, and two stations would be located between Devils Canyon and the Talkeetna River confluence. All study stations established within the Middle River segment would be located at focus areas described in detail in Study 8.5 (fish and aquatics instream flow), in an attempt to correlate macroinvertebrate data with additional environmental data (e.g., flow, substrates, temperature, water quality, riparian habitat, etc.) collected by other studies, for uses in statistical analyses, and HSC/HSI development.

In the Lower River segment, one study station would be located around the Trapper Creek area (RM 92.5–97), approximately 5 miles downstream from the three rivers confluence. The study station would include a mainstem site, side channel site, and a side slough site, the specific stations of which would be selected following site reconnaissance.

In addition, one station would be established in the Talkeetna River to assess the feasibility of the Talkeetna River as a reference river for post-project monitoring activities at the Susitna River study stations. Habitat typing has not been conducted in the Talkeetna River, so AEA proposes to initially select the Talkeetna River reference feasibility station using aerial imagery and maps, with a field reconnaissance trip to select a final study station. AEA proposes that the ideal station on the Talkeetna River for the feasibility study would be a match with physical conditions similar to one of the focus areas selected in the Middle Segment of the Susitna River, and would include a main channel site, a side channel site, and a side slough site.

Objectives and proposed methods for the study are summarized below.

1) Synthesize existing literature and prepare a written report summarizing the impacts of hydropower development and operations (including temperature and turbidity) on benthic macroinvertebrate and algal communities.

2) Characterize the pre-project benthic macroinvertebrate and algal communities with regard to species composition and abundance in the Susitna River. This would include the following study elements that would be implemented at the eight study stations (24 sites) identified above.

    a. Benthic macroinvertebrate and algae sampling would be conducted during three sampling periods from April through October in both study years (2013 and 2014) to capture seasonal variation in community structure and productivity.

b. Benthic macroinvertebrate and algae sampling would be conducted in riffle/run mesohabitats within mainstem and off-channel macrohabitat types (i.e., tributary confluences, side channels, and sloughs).

c. Benthic macroinvertebrate sampling would be conducted using a modified Hess sampler.

d. Measurements of depth, mean water column velocity, mean boundary layer velocity (near bed), and substrate composition would be taken concurrently with benthic macroinvertebrate and algae sampling at each site, and water temperatures would be monitored hourly with submerged temperature loggers deployed throughout the ice-free season. Turbidity and light availability would be measured concurrently with benthic algae sampling at each site. Temperature and flow monitoring would be coordinated with Study 5.5 (water quality monitoring) and Study 8.5 (fish and aquatics instream flow).

e. Floating emergence traps would be deployed at each site and checked monthly to determine both the timing and the amount of adult insect emergence from the Susitna River.

f. Large woody debris (LWD), if present at a sample site, also would be sampled for benthic macroinvertebrates.

g. In conjunction with the proposed bioenergetics modeling, biomass estimates would be calculated for primary invertebrate taxa collected from benthic and emergence sampling. For a select sub-sample of the collection, energy density (Joules/g wet weight) would also be estimated from the percent dry mass (dry mass/wet mass) of each sample.

h. For two selected study stations, portions of benthic macroinvertebrates, organic matter, and algal material would be used for stable isotope analysis.

i. Any invasive algae taxa identified in the sample collections would be identified and their stations would be recorded.

j. To address the effects of changing flow patterns on benthic macroinvertebrates, algae, and benthic organic matter, additional sampling would be conducted both before and after storm events that meet or exceed a 1.5-year flood event at two side-slough sites, located in two separate focus areas in the Middle River segment between Portage Creek and Talkeetna. Sampling would be conducted for two storm events per year.

3) Estimate invertebrate drift in selected habitats within the Susitna River to assess food availability to juvenile and resident fishes. AEA proposes to conduct drift sampling concurrently with benthic macroinvertebrate sampling at all sites within the study stations to assess drift density, drift rate, and drift composition. Results would allow for comparisons between the drift component of the benthic macroinvertebrate community and available terrestrial macroinvertebrates, and assess the compositions and availability of invertebrates to fish predation. The following methods are proposed for drift sampling:

   a. Sampling would be conducted in riffle/run habitats within the mainstem sites and associated off-channel habitat sites.

   b. Sampling would be conducted during daylight hours, using drift nets with 250-micrometer mesh size.

   c. Samples at two selected stations in the Middle River segment would be tested for the stable isotope analysis task (RSP section 9.8.4.5.2). Organic matter content would be retained and analyzed by size (coarse and fine particulate organic matter).

   d. In conjunction with the proposed bioenergetics modeling, biomass estimates would be taken for primary invertebrate taxa collected in drift samples. For a select sub-sample of the collection, energy density would also be estimated from the percent dry mass of each sample.

   e. For two selected stations, portions of terrestrial invertebrate composition and organic matter in drift samples would be utilized for stable isotope analysis.

4) Conduct a feasibility study in 2013 to evaluate the suitability of using a reference site on the Talkeetna River as part of a long-term monitoring program with Susitna River sites to help differentiate potential long-term changes that are project-related versus those occurring for other reasons.

   Benthic and drift sampling in the Talkeetna River would occur during approximately the same periods as sampling in the Middle River segment, with seasonal sampling during 2013. Proposed benthic macroinvertebrate, benthic algal, and drift sampling methods and processing protocols are identical to those proposed for sampling in the Middle River segment. In the first quarter of 2014, AEA proposes to compare sampling results from the Talkeetna site with results from similar sites in the Middle River segment to determine whether the Talkeetna River would serve as a suitable reference site. Statistical analysis is proposed to test for similarities and significant differences between Talkeetna site and Middle River segment sites by comparing community compositions and a collection of calculated metrics. Results indicating close similarities, or no significant differences, between sites on the two rivers would indicate suitability as a reference.

5) Conduct a trophic analysis, using trophic modeling and stable isotope analysis, to describe the food web relationships within the current riverine community within the Middle and Upper River.

To complement the fish habitat suitability analysis, which focuses on physical habitat features, AEA proposes to develop trophic models to incorporate the density and quality of prey into an estimate of habitat quality. Model inputs would include field data on growth rate, water temperature, diet composition, and the energy density of prey. This analysis would allow comparisons of observed growth rates, estimated consumption rates, and estimated growth efficiency (i.e., the grams of growth achieved per gram of food consumed) among different habitats under the environmental conditions observed during 2013 and 2014. AEA proposes to estimate consumption and growth efficiency using Wisconsin bioenergetics models with species-specific physiological parameters for Chinook salmon, coho salmon, and rainbow trout/steelhead. Simulations for each species would encompass the full range of age classes for which sufficient field data are collected; at a minimum, these are expected to include ages 0–1 for Chinook salmon, 0–2 for coho salmon, and 0–8 for rainbow trout. Modeled estimates of daily consumption rates and growth efficiency would be compared among macrohabitats and seasons to determine whether growth is currently limited by water temperature, food consumption, or food quality in the study area and whether the limiting factors differ among macrohabitats.

In addition to the descriptive bioenergetics analysis, AEA proposes to develop a growth rate potential (GRP) analysis and evaluate it as a potential prospective approach for predicting fish growth rates under changing environmental conditions. Species-specific GRP models for juvenile coho salmon and juvenile rainbow trout would link a drift foraging model to a Wisconsin bioenergetics model. Mechanistic drift foraging models are not available for juvenile Chinook salmon, so the growth rate potential approach is not proposed for Chinook. The foraging models would estimate a consumption rate based on stream flow, turbidity, and prey density input data. The bioenergetics models would predict a growth rate from inputs of consumption, body size, water temperature, diet composition, and the energy density of prey. Preliminary GRP models for each species would be developed using data from the 2013 field season as well as from prior Susitna Basin studies. AEA proposes to test initial model predictions of the growth potential of particular sites by comparison with the observed growth and distribution of fish captured in those sites. A sensitivity analysis would be conducted to identify the most important parameters for further refinement.

AEA proposes to test the suitability of the GRP models for predicting the growth rates of each species using an information theoretic model selection approach. For each species, a full model would be fit to the observed growth data using the observed water temperature, stream flow, turbidity, prey density, prey quality (energy density), and competitor density as explanatory variables. A set of simplified growth models would also be constructed using every possible subset of those variables. The full suite of candidate growth models would be fit to the data, and the simplest models would be identified to evaluate whether the GRP approach or simpler approaches may serve as useful tools for future predictive analyses of the effects of future environmental changes on fish growth in the Susitna River.

AEA proposes to conduct a stable isotope analysis to determine the relative contributions of freshwater, terrestrial, and marine nutrients to focal salmonid species along an upstream-downstream gradient and among habitat types in the river. Results would be used in conjunction with the bioenergetics model to further explain the energy source pathways and trophic relationships in the Susitna River food web. Stable isotope samples would be collected from algae, organic matter collected by benthic sampling, organic matter collected by drift sampling, spawning salmon, aquatic and terrestrial macroinvertebrates, and focal salmonid fishes. Isotope samples would be collected at two of the study stations in the Middle River, with three habitat-specific sampling sites per station, for a total of six sampling sites. To account for temporal variability in isotopic signatures, all sample types would be collected during three seasonal periods, with the exception of salmon carcasses, which would be collected only during the spawning run.

6) Develop habitat suitability criteria for Susitna River benthic macroinvertebrate and algal habitats to predict potential change in these habitats downstream of the proposed dam site.

AEA proposes to develop and integrate literature-based draft HSC curves (i.e., depth, velocity, and substrate/cover) and HSI models (i.e., turbidity, duration of inundation, and dewatering) for benthic macroinvertebrate and algae communities to analyze the effects of alternate operating scenarios on these communities. Because benthic macroinvertebrate and periphyton communities are composed of numerous taxa, AEA proposes to develop the HSC/HSI curves for commonly used benthic metrics (e.g., biomass, chlorophyll-a [algae], density, diversity, or dominant taxa) selected to summarize and describe the communities. The selection of individual species of interest would consider the dietary preferences of the target fish species selected for the trophic analysis. Habitat suitability information would address benthic macroinvertebrate and algal responses to changes in depth, velocity, substrate, turbidity, and frequency of inundation and dewatering.

AEA proposes to then develop a histogram (i.e., bar chart) for each of the habitat parameters (e.g., depth, velocity, substrate, frequency of dewatering) using site-specific field data collected in 2013 as part of this study, and compare the histograms to the literature-based HSI curves to validate the applicability of the curves for aquatic habitat modeling. As a final step, the TWG would confirm HSC/HSI curves for each benthic metric. Using a roundtable discussion format, the TWG would review literature-based benthic community information and site-specific data to develop a final set of HSC/HSI curves. AEA proposes to use the final curves in Study 8.5 (fish and aquatics instream flow) to define the relationship between habitat quantity and quality for each of the selected benthic metrics under various operating scenarios. Analysis and modeling efforts would be coordinated with the instream flow study team.

7) Characterize the invertebrate compositions in the diets of representative fish species in relationship to their source (benthic or drift component).

AEA proposes to investigate the trophic relationship between fish and their benthic and terrestrial food sources by conducting a fish gut analysis and comparing results to drift and benthic macroinvertebrate data. In support of the bioenergetics modeling, fish species proposed for dietary analysis includes juvenile coho salmon, juvenile Chinook salmon, and juvenile and adult rainbow trout, as identified in consultation with the TWG. Fish collection sites would correspond to all sites within the study stations to allow for comparison with the benthic macroinvertebrate community and drift compositions.

For this study component, AEA proposes to sample eight fish per species/age class per sample site for fish stomach contents, using non-lethal techniques. Scales would also be collected for age and growth analysis. At two selected study stations in the Middle River segment, fin clips would be obtained from five fish at each site for use in the stable isotope analysis. The fish collection methods and scheduled sampling efforts would be coordinated with the study teams for Study 9.5 (upper river fish distribution) and Study 9.6 (middle and lower river fish distribution).

For each fish species, AEA proposes to calculate the diet composition and age class in terms of diet proportions by weight, and identify potential ontogenetic shifts in diet. Diet composition would be compared along an upstream-downstream gradient and among habitat types and seasons for each fish species and age class using multivariate statistics.

8) Characterize organic matter resources (e.g., available for macroinvertebrate consumers) including coarse particulate organic matter, fine particulate organic matter, and suspended organic matter.

To quantify the amounts of organic matter available in the Susitna River for river productivity, AEA proposes to collect coarse particulate organic matter and fine particulate organic matter (specifically, fine benthic organic matter) concurrently with all benthic macroinvertebrate sampling. Suspended fine particulate organic matter (seston) would be collected from material in invertebrate drift samples. All organic debris collected within each benthic or drift sample would be retained after processing, to evaluate organisms in the sample, and preserved for analysis.

AEA proposes to compare organic matter density among sites to identify differences in organic matter content between habitat types, as well as spatial trends along the length of the river and temporal the interannual (seasonal) and annual variability in the amounts of organic matter within the sampled substrates. Statistical tests would be used to determine if there are significant differences among sites, stations, seasons, and years.

9) Estimate benthic macroinvertebrate colonization rates in the Middle River segment under pre-project baseline conditions to assist in evaluating future post-project changes to productivity in the Middle River.

To assess the influences of turbidity and temperature on the benthic community colonization rates, AEA proposes a field study for both study years (2013 and 2014) to estimate potential benthic macroinvertebrate colonization rates for four different habitat types that reflect these conditions in the Susitna River. Due to the difficulty of isolating each of these conditions under natural conditions, AEA proposes to examine colonization under turbid/warm, clear/warm, turbid/cold, clear/cold conditions.

To locate areas that display these conditions, AEA proposes to determine study stations and scheduling after reviewing all studies done in the segment, along with discussions with other research teams conducting field studies in the Middle River segment. AEA also proposes site reconnaissance trips to assess candidate sites.

Pre-conditioned Hester-Dendy multiplate samplers are proposed as the artificial substrates for the colonization rate study. Sets of three preconditioned artificial substrates would be deployed incrementally for set periods of colonization time (e.g., 8, 6, 4, 2, and 1 week[s]) and then pulled simultaneously at the conclusion of the colonization period. Artificial substrates would be deployed at two depths at fixed sites along the channel bed. The station, depth, velocity (both 60 percent of depth and near-bed measurements), photosynthetically active radiation levels, and turbidity would be measured and recorded for each deployment.

Results generated from the collections would include a variety of descriptive metrics commonly used in aquatic ecological studies. AEA proposes to compare exposure times, depths, and conditions to examine trends of benthic macroinvertebrate colonization. Colonization information would be compared with colonization results from other river systems and, in the future, with post-project colonization results. In addition, results would be used in HSC/HSI development, and in the varial zone modeling task in Study 8.5 (fish and aquatics instream flow) to assist in determining the potential effect of project-related short-term flow fluctuations on benthic macroinvertebrates.

Comments on the Study

Agency Study Objectives

In their March 18, 2013 comments, NMFS and FWS list their objectives for the river productivity study. NMFS states that its primary objective for this study is to determine how differences in macroinvertebrates, organic matter, and primary production among the major macrohabitats of the Susitna River influence fish distribution and production. FWS states a similar objective, which is to characterize the macroinvertebrate community and determine organic matter and primary production among macrohabitats and macrohabitat types in the Susitna River and its subsequent influence on fish distribution and production.

Additional study objectives identified by both NMFS and FWS are:

- Evaluate how the project can indirectly affect the fish community through changes in the abundance of food resources and the transfer of energy among trophic levels.

- Understand the portion of total fish production within the Susitna River that comes from carbon and macronutrients of marine origin.

- Determine how seasonal and daily modifications in flow may affect habitat use by macroinvertebrates.

Discussion and Staff Recommendation

The agencies' study objectives are generally consistent and compatible with AEA's study objectives. However, in addition to food availability, many variables including habitat type and structure, water velocity, water depth, water temperature, water chemistry, turbidity, photoperiod, season, ice processes, and others may influence the fish community. Determining the response of fish distribution to specific changes solely on the abundance of food resources and the transfer of energy among trophic levels, as the agencies' comment seems to suggest, would be very difficult and beyond AEA's ability to control or eliminate these other variables. We note, however, that AEA's proposed suite of studies would consider many of these variables and AEA's Integrated Resource Analysis (RSP section 8.5.4.8) should assimilate the results of each applicable study to address the fish distribution observed in the Susitna River that results from AEA's fish distribution and abundance studies.[45]

AEA's proposed sampling strategy for this study, *River Productivity,* should capture the range of variability in macroinvertebrates, organic matter, and algae in and among the sampled macrohabitat types in the Middle River and would describe the existing condition of these resources, identify differences among habitats, and support an analysis of project effects on these resources and habitats (section 5.9(b)(5)).

The Middle River segment contains spawning, rearing, and overwintering habitat for a wide range of fish species and life stages, including anadromous salmonids. As such, AEA proposes to concentrate sampling in the Middle River to provide data necessary to assess indirect effects on the fish community on a number of variables (e.g. habitat type and structure, water velocity, water depth, water temperature, water chemistry, turbidity) including the abundance of food resources and the transfer of energy among trophic levels. Additionally, AEA proposes to develop habitat suitability criteria and indices (HSC/HSI) for algae and macroinvertebrates to facilitate analysis of effects on river productivity and fish food resources that may result from project-related changes in environmental variables. The HSC/HSI would also provide the necessary information to determine how seasonal and daily modifications in flow may affect habitat use by macroinvertebrates, which is another of the agencies' study objectives. Finally, AEA's proposed stable isotope study [RSP section 9.8.4.9 and River Productivity Implementation Plan (RPIP) section 2.11] would provide an understanding of the contribution of marine carbon and macronutrients to fish production in the Susitna River.

The agencies' comments do not indicate how AEA's proposed sampling strategy in its entirety is insufficient to address the agency objectives (section 5.9(b)(4)). AEA's proposed sampling strategy should provide the information necessary to characterize the resources (section 5.9(b)(4)), as requested by the agencies and evaluate potential project effects (section 5.9(b)(7)).

No modifications to the study plan are recommended.

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[45] Study 9.5 (fish distribution and abundance in the upper Susitna River,) and study 9.6. (fish distribution and abundance in the middle and lower Susitna River) are specifically designed to monitor fish distribution in the Susitna River.

Modified Sampling Locations

In their March 18, 2013 comments, NMFS and FWS state that the two study stations in the Upper River mainstem, upstream of the reservoir inundation zone (RP-248 and RP-233),[46] would not provide information to address the NMFS and FWS study objectives (as summarized above in *Agency Study Objectives*). NMFS and FWS additionally state that the two stations between the dam and Devils Canyon (focus areas 184 and 173) would not efficiently meet the study objectives because the direct effects of physical habitat changes (i.e., flow and stage height) to the fish community would likely outweigh the potential indirect effects from reduced river productivity.

As a result, FWS requests that AEA replace the two Upper River mainstem stations (RP-248 and RP-233) and the two stations between the proposed dam and Devils Canyon (focus areas 184 and 173) designated for river productivity sampling, with four alternate stations downstream in the Middle River. As replacement stations, FWS requests that AEA include river productivity sampling within the proposed focus areas at Slough 8A (focus area 128) and Slough 6A (focus area 115), and establish two new focus areas: one at Fourth of July Creek and one within Middle River reach 7 (MR7) near Lower McKenzie Creek or at Oxbow II, below Curry. As an alternate to one of the four requested Middle River focus areas, FWS states that AEA could use the proposed focus area 138, downstream of Gold Creek. AEA does not propose river productivity sampling at any of these suggested focus areas (128, 115, or 138).

NMFS requests that AEA move focus area 171 to a site that includes 4th of July Creek and the sloughs upstream, and move focus area 151 to a site in MR7, possibly near Lower McKenzie Creek or below Curry on old Oxbow II. NMFS also requests an additional focus area located in MR8 below Whiskers Creek and upstream of the three rivers confluence (RM 98.5).

Discussion and Staff Recommendation

AEA's two proposed study stations in the Upper River segment (RP-248 and RP-233) are upstream of the proposed reservoir inundation zone in an area where the geomorphic processes, physical habitat characteristics, and ecological interactions are likely to differ substantially from those in the Middle River and Lower River. However, there is no reason to expect that the project would affect macroinvertebrates, algae, or organic matter in the Susitna River upstream of the proposed reservoir, where RP-233 and RP-248 are located (section 5.9(b)(5)). As a result, river productivity sampling in this

[46] Sample site numbers indicate river mile (RM) station of the sample site.

Upper River segment would not render data to evaluate potential project effects (section 5.9(b)(4)) and removing these two study stations would reduce the cost of the study by approximately $300,000 (section 5.9(b)(7)).

Focus areas 184 and 173 are the first two focus areas downstream of the proposed dam, and would likely be subjected to the greatest influence of the proposed project's construction, operation, and maintenance (section 5.9(b)(5)). The FWS request to relocate these focus areas fails to acknowledge the importance of the data to be collected there (5.9(b)(4) and (7)). Despite only limited use of this area by anadromous salmonids, macroinvertebrate data collected in this area would provide an indication of food availability for resident fishes within this reach, and provide the data necessary to evaluate longitudinal differences in river productivity that may result from project-related effects (section 5.9(b)(4) and (5)).

Regarding FWS' request for additional focus areas in the Middle and Lower River, with our recommendation (discussed below under *Macrohabitat Replicates)* to increase the sampling effort at the four Middle River stations and the one Lower River station, the information needed to evaluate potential project effects and inform the NMFS and FWS study objectives would be collected. Therefore, we do not consider it necessary to add any new focus areas as requested by FWS.

We address NMFS' request to move focus areas 171 and 151, and their suggestion of an additional focus area located in MR8 below Whiskers Creek and upstream of the three rivers confluence, in our analysis of Study 8.5 (fish and aquatics instream flow).

We recommend that AEA remove the proposed Upper River mainstem study stations (RP-248 and RP-233).

Macrohabitat Replicates

In their March 18, 2013 comments, NMFS and FWS state that the five macrohabitat types[47] differ in water quality, physical characteristics, water depth and velocity, and in their interaction with the main channel. The agencies assert that it is therefore likely that there are differences in macroinvertebrates and organic matter among

[47] The five macrohabitat types recognized by NMFS and FWS are tributary mouths, main channel, side channel, side slough, and upland slough. Whereas AEA categorizes single main channels and split main channels as two separate macrohabitat types, the agencies consider them to be a single main channel macrohabitat type.

the three sampling sites (one main channel site and two associated off-channel sites) at each station and that project effects would vary among these habitats types.

As a result, NMFS and FWS request that AEA sample at six stations in the Middle River segment downstream of Devils Canyon and measure benthic and drifting (or planktonic) macroinvertebrates, algal chlorophyll-a, and biomass of organic matter and algae within all five macrohabitat types at each study station, resulting in 30 Middle River sample sites instead of the 12 proposed by AEA.

Discussion and Staff Recommendation

In the Middle River segment (RM 102.4 to RM 187.1), AEA proposes sampling macroinvertebrates, algae, and organic matter at four stations,[48] including two stations between the proposed dam and Devils Canyon and two stations downstream of Devils Canyon. AEA proposes to collect samples at three sites within each of the Middle River study stations (a main channel site and two associated off-channel sites), for a total of 12 sites.

Each of the macrohabitat types present at the proposed focus areas in the Middle River likely differ in water quality, physical characteristics, water depth and velocity, and in their interaction with the main channel. Therefore it is likely each site would also demonstrate differences in macroinvertebrates, algae, and organic matter, and that any project effects would vary at each site. However, AEA's proposal would not sample each available macrohabitat; instead, AEA would randomly select and sample three of the available macrohabitat types present within each study station. AEA's sample strategy could result in the underrepresentation or even the omission of a macrohabitat type from its study effort (section 5.9(b)(6)).

As such, the sampling scheme requested by the agencies would ensure all available macrohabitats would be sampled, capturing each site's unique characteristic and ensuring that no macrohabitat may be left underrepresented through the study effort (section 5.9(b)(7)). However, information provided in AEA's final RPIP indicates that only one of AEA's proposed focus areas in the Middle River (focus area 104) contains all five macrohabitat types and thus it is not possible to sample five unique macrohabitats at each of the study stations as requested by the agencies.[49] Alternatively, simply sampling

[48] One additional focus area would be sampled exclusively during storm events.

[49] We note that none of the replacement focus areas suggested by NMFS and FWS in the Middle River (focus areas 138, 128, and 115) contain more than four of the five macrohabitat types either. However, information on macrohabitat types present at the

all macrohabitat types present at each study station would ensure all macrohabitat type present are sample and better represented, improving data integrity and supporting a better analysis of how potential project effects may vary among the habitat types (section 5.9(b)(7)).

According to AEA's final RPIP, the four proposed study stations in the Middle River contain a total of 16 macrohabitat types.[50] The Lower River study station includes all five macrohabitats. Therefore, sampling in all available unique macrohabitat types at each of AEA's proposed stations in the Middle and Lower River would, provide 21 sample sites (versus the 15 proposed). This approach would provide replicate samples in all available macrohabitat types to discern differences in macroinvertebrates, algae, and organic matter, and fish growth among macrohabitat types, and provide greater data integrity to inform an analysis of the proposed project than AEA's proposal (sections 5.9(b)(4), (5), and (7)). We estimate the cost of applying this sample scheme in the Lower and Middle River study stations to be $110,000 (section 5.9(b)(7)).

Therefore, we recommend that AEA sample in all unique macrohabitat types present at each proposed study station for river productivity sampling in the Middle River and Lower River segments. This would result in 16 sites in the Middle River and five sites in the Lower River. AEA should collect samples in each macrohabitat type as feasible using sampling methods and devices proposed in its RSP and final RPIP, with the modifications we recommend below in *Turbidity and Vegetation Influence*, *Benthic Sampling Methods, Water Column and Surface Sampling, Organic Matter Sample Processing, Benthic Macroinvertebrate Sampling on Snags, Emergence Sampling,* and *Trophic Modeling*.

Turbidity and Vegetation Influence

In their March 18, 2013 comments, NMFS and FWS stress the potential importance of tributary mouths for fish, which they assert may be explained by increased drift density and prey capture efficiency due to reduced turbidity. NMFS and FWS state that benthic, drift, organic matter, and algal sampling sites should be located on the mainstem upstream and just downstream from the tributary confluence. They assert that these areas are most likely to have differences in turbidity, and suggest that this sampling

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new focus areas requested by NMFS and FWS (one at Fourth of July Creek and one in MR7 near Lower McKenzie Creek or in Oxbow II below Curry) is not available.

[50] This includes the tributary mouth just downstream of focus area 184 and a number of single main and split main channels.

strategy can: (1) be used to evaluate the relative contributions of invertebrate drift from the mainstem Susitna River and its tributaries; (2) provide data to estimate how project-related changes in turbidity may affect the abundance of algae and macroinvertebrates that may influence productivity and fish distribution; and (3) demonstrate how reduced suspended sediment may change the abundance of macroinvertebrates in the scraper and filterer functional feeding groups.

Additionally, NMFS and FWS assert that fish distribution among mainstem sites likely varies between meander edges with overhanging vegetation and point bars that have no cover, and suggest that proximity to riparian vegetation may provide a terrestrial food source for fish. They contend that decreasing flows (as a result of project operations) could alter the amount and duration of time that edge habitat is available to fish by moving the edge of water away from the vegetation line. Therefore, at each main channel or side channel sample site, NMFS and FWS request that AEA sample macroinvertebrate drift at meander edges with overhanging vegetation and at unvegetated point bars, to determine if terrestrial invertebrates within the drift are greater based on proximity to riparian vegetation.

Discussion and Staff Recommendation

Turbidity

Regarding how project-related changes in turbidity may affect the abundance of algae and macroinvertebrates that may influence productivity and fish distribution; we discuss the agencies goal to have the proposed river productivity studies evaluate potential effects on fish distribution above in *Agency Study Objectives.*

AEA’s proposal to develop habitat suitability criteria and indices (HSC/HSI) for algae and macroinvertebrates (RSP section 9.8.4.10) would facilitate analysis of effects on river productivity and fish food resources that may result from project-related changes in turbidity and other environmental variables. In addition, AEA proposes to model the effects of turbidity on fish prey consumption rate as one component of a growth rate potential model for coho salmon and rainbow trout (RSP section 9.8.4.8 and RPIP section 2.10). The proposed HSC/HSI and growth rate potential modeling would directly evaluate the link between turbidity and the availability and consumption of macroinvertebrate prey by fish (section 5.9(b)(6)). We therefore conclude that AEA’s proposed study methods are adequate to meet the study objectives and evaluate potential turbidity-related project effects on fish food resources, and the agencies’ requested study modifications to collect benthic macroinvertebrate and algal samples upstream and downstream of tributaries are unnecessary (section 5.9(b)(7)).

However, macroinvertebrate drift sampling upstream and downstream of tributaries would provide information needed to assess the relative contribution of tributaries and the mainstem Susitna River to fish food resources (section 5.9(b)(4)). This information would inform the assessment of fish food availability, which is among AEA's stated study objectives, and can be used to evaluate the potential effects of project-related changes in macroinvertebrate drift on fish food resources in the Susitna River (section 5.9(b)(5) and (7)). We anticipate that bracketing the tributary mouths for drift sampling would require little or no additional effort relative to AEA's proposed drift sampling methods, and as such any associated costs would be minimal (section 5.9(b)(7)).

Regarding the agencies' request for sampling algae on the mainstem upstream and just downstream from the tributary confluence, we recognize that turbidity has a direct influence on primary production and algal abundance. However, AEA proposes to measure turbidity and photosynthetically active radiation (PAR) at benthic algae sample sites to assess the effects of turbidity on algal abundance. We note that the agencies do not explain why AEA's proposed method is inadequate to assess project effects on the abundance of algae or why their requested method for sampling upstream and downstream of tributaries is a superior method to assess the relationship between turbidity and algal production (section 5.9(b)(7)). We note however that, as discussed above in *Macrohabitat Replicates*, we recommend sampling for benthic algae in all macrohabitat types present at each study station, including tributary mouths, side sloughs, and upland sloughs, each of which typically has relatively clear, non-turbid water. Algal sampling in these three macrohabitat types, per our recommendation, would provide measures of algae under non-turbid conditions that can be compared with turbid conditions from main channel sample sites and be used to assess differences among macrohabitat types, if deemed appropriate (section 5.9(b)(4)).

Regarding the potential effects of turbidity on the abundance of certain macroinvertebrate functional feeding groups, NMFS and FWS do not explain or justify why it is necessary to estimate how reduced suspended sediment may change the abundance of macroinvertebrates in certain functional feeding groups, or how an understanding of functional feeding group ecology would help meet study objectives or evaluate potential project effects (section 5.9(b)(5)). With the modifications we recommend above (see *Macrohabitat Replicates*), we consider AEA's proposal to measure turbidity at BMI sample sites and to study BMI colonization rates under turbid and non-turbid conditions to be a reasonable approach for collecting the information necessary to evaluate aquatic productivity within the context of the proposed project (section 5.9(b)(6)).

Riparian Vegetation

Regarding the potential influence of riparian vegetation on fish distribution and input of terrestrial invertebrates to the drift, the agencies suggest that overhanging riparian vegetation on the banks of the Susitna River main channel is sufficient to provide enough terrestrial invertebrate input to cause measurable changes in terrestrial invertebrate drift, and therefore, influence fish food availability and subsequently fish distribution. We discuss the agencies' goal to have the proposed river productivity studies evaluate potential effects on fish distribution above in *Agency Study Objectives.*

Project operation would likely reduce river stage during the summer months due to decreased flow which would increase the distance between the edge of water and the riparian vegetation line, resulting in a potential project effect (section 5.9(b)(5)). However, upon review of ground-level photos included in the LWD Reconnaissance technical memo and the high resolution focus area imagery included with the river productivity implementation plan, it is apparent that the existing main channel banks of the Susitna River have a substantial area above the active river channel margin that is largely devoid of vegetation due to the scouring effects of ice and seasonal flow fluctuations. As a result, overhanging riparian vegetation is limited due to the width and longitudinal extent of this unvegetated zone (section 5.9(b)(4)). Therefore, it is unlikely that terrestrial invertebrate input from streamside vegetation contributes sufficiently to invertebrate drift that it would warrant the added effort requested by the agencies (section 5.9(b)(7)).

We recommend that AEA conduct macroinvertebrate drift sampling upstream and immediately downstream of tributary mouths to collect information needed to assess the relative contribution of tributaries and the mainstem Susitna River to fish food resources.

Benthic Sampling Methods

In their March 18, 2013 comments, NMFS and FWS state that AEA's proposed methods to sample benthic macroinvertebrates (BMI) would not be able to determine the abundance and availability of food sources for resident fish species that feed in benthic depositional habitats (e.g., burbot, longnose suckers, and juvenile whitefish). As such, NMFS and FWS state that the use of only one type of sampler (Hess) to collect BMI and benthic organic matter, as proposed by AEA, is not generally the accepted practice of the scientific community when attempting to document the range of variability in the parameters among habitats. NMFS and FWS point out that study results would be used to develop HSC/HSI, and contend that samples must therefore be collected under conditions of variable depth, velocity, substrate, cover, and turbidity.

As such, the agencies request that AEA use a dredge or bottom grab sampler (e.g., Peterson, Ponar, Ekman) to sample macrohabitats with fine substrate and low velocities, which include the backwater mouths of side sloughs, upland sloughs, and some tributaries with low slopes. They also request that a dome sampler or box sampler with a battery operated pump that removes dislodged materials be used to collect two or three of the requested five samples[51] at each of the study stations. This method requires that a diver, usually using SCUBA gear, dislodge material for collection.

To support HSC/HSI development and to investigate relationships between algal chlorophyll-a and solar radiation, NMFS and FWS request that AEA collect samples from multiple depths within each study station. The agencies also request that AEA sample periphytic algae and aufwuchs[52] from fine substrates within depositional habitats. In main channel and side channel macrohabitats, they request that AEA collect two or three of the requested five algal samples in deeper water habitats (0.5 to 2 m). For depositional areas, the agencies request that AEA collect algae by taking a core of fine substrate to a depth of approximately 5 cm, and processing the samples as proposed by AEA for samples collected from cobbles. For deep water depositional areas, the agencies request that AEA collect bed sediment from the upper surface of an intact dredge sample. They state that an alternative method for algal sampling in depositional areas is to use artificial substrates for algal colonization.

<u>Discussion and Staff Recommendation</u>

Collection of BMI and benthic algae samples in macrohabitats with fine substrate and low velocities (e.g., side sloughs and upland sloughs) is necessary to evaluate food availability for resident fish species that feed in these habitats and for development of HSC/HSI for these benthic taxa. While we note that AEA does not propose to sample these habitats for BMI or benthic algae, we recommend above in *Macrohabitat Replicates* that AEA sample in all unique macrohabitat types present at each study station. Because it is not feasible to use the Hess sampler proposed by AEA in habitats with deep water (> 40 cm), fine substrate or low velocities, the benthic dredge or grab sampling requested by the agencies should be employed to collect BMI benthic algae samples (section 5.9(b)(6)).

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[51] NMFS and FWS request that AEA sample in five macrohabitat types per study station (see *Macrohabitat Replicates*, above).

[52] Aufwuchs is a community of aquatic organisms and detritus adhering to and forming a surface coating on submerged hard substrates.

With regard to the agencies' request that bottom sampling include methods requiring diver-operated samplers, sediment cores, and artificial substrates, we note that the requested benthic dredge or grab sampling would provide BMI and benthic algae samples, thus assessing food sources for resident fish species that feed in these habitats and provide the information the agencies request (section 5.9(b)(4) and (7)).

Because algae are photosynthetic and light penetration is affected by water depth, especially in seasonally turbid glacial rivers like the Susitna, benthic sampling at various water depths across the river channel, as requested by the agencies, would provide information on the relationship between algal production and water depth (section 5.9(b)(4)). However, AEA's proposed methods for sampling benthic algae do not specify the water depths at which samples would be taken (section 5.9(b)(7)). Sampling at various water depths would inform an analysis of how the project's potential effects on flow fluctuations and corresponding stage changes may influence algae production at various depths (section 5.9(b)(5)).[53]

Using AEA's proposed methods, sampler design and safety concerns limit the depth and velocity at which sampling cobble substrates could occur. With AEA's proposed sampling method, it is likely that sampling within the river channel would be limited to depths 3 feet and less, a safe wadeable limit depending on water velocity. Because much of the Susitna River is deeper than 3 feet, sampling of this deeper water habitat likely would not occur using AEA's proposed methodology. However, we note that AEA anticipates project operations would result in water level fluctuations of 1–2 feet. As a result, benthic sampling at various water depths across the river channel, up to a depth of 3 feet is a reasonable approach that takes into consideration worker safety while still allowing sampling at a range of depths sufficient to evaluate potential effects within the range of the anticipated project-related water level fluctuations (section 5.9(b)(5) and (6)).

Benthic dredge or grab sampling, together with AEA's other proposed sampling methods (e.g., BMI, benthic algae, macroinvertebrate drift, macroinvertebrate colonization) and at each macrohabitat type (as recommended above in *Macrohabitat Replicates*), would enable collection of data in a range of depth, velocity, substrate, and turbidity conditions for development of HSC/HSI, as specified by NMFS and FWS, and would facilitate evaluation of potential project effects. We estimate the additional cost of sampling at various depths within the river channel and in areas of fine substrate and low

[53] AEA's preliminary flow routing model results indicate that daily water level fluctuations in the range of 1–2 feet may be expected at some stations.

velocities and the cost of processing the additional samples to be $85,000 (section 5.9(b)(7)).

Therefore, we recommend AEA collect BMI and algae samples in macrohabitats with fine substrate and low velocities using a bottom dredge or grab sampler. AEA should select the most appropriate sampler according to the bottom substrate, water velocity, and other conditions (see Klemm et al. 1990), but should endeavor to use the same sampler in all macrohabitats of this type to ensure consistency among samples. Additionally, 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.

Water Column and Surface Sampling

In their March 18, 2013 comments, NMFS and FWS note that AEA's study proposal does not identify a method for sampling macroinvertebrates within the water column or on the water surface of still water habitats. The agencies state that water column or surface feeding fish, including juvenile sockeye, coho, and Chinook salmon and resident Dolly Varden and rainbow trout, are found in still water off-channel habitats, and assert that documenting food resources within these habitats is therefore an important study component.

Accordingly, the agencies request that AEA sample macroinvertebrates in the water column, on the water surface, and on aquatic plants within upland sloughs, the mouths of side sloughs, and depositional zones of tributary mouths using a modified plankton tow. They also suggest that a floating frame drift net could be towed by boat through the sample site to conduct this type of sampling. The agencies request that AEA conduct water column and water surface sampling at two transects within each sample site.

Discussion and Staff Recommendation

AEA proposes to sample macroinvertebrate fish food resources in the water column and on the surface in moving water habitats in the main channel (riffles and runs) using drift nets, and to measure biomass of emerging adult aquatic insects using floating emergence traps. AEA does not propose macroinvertebrate sampling in the water column of off-channel macrohabitats such as sloughs that have little or no water velocity, as requested by the agencies (section 5.9(b)(4)).

These off-channel macrohabitats are important rearing and feeding locations for a variety of fish in the Susitna River, including juvenile sockeye, coho, and Chinook salmon, as well as resident Dolly Varden and rainbow trout. Documenting the fish food resources in these still water habitats is an objective of Study 9.8 (river productivity) and would provide data to support an analysis of potential project effects on this resource (section 5.9(b)(5)).

We interpret the agencies' request that AEA conduct water column invertebrate sampling at two transects in each sample site as requesting two such transects within each macrohabitat type sampled. However, the agencies provide no rationale on the need for two transects or the cost that would be incurred (section 5.9(b)(7)). Similarly, the agencies request that AEA sample invertebrates on aquatic plants, but do not explain: (1) how this could be accomplished using their suggested sampling methods (i.e., modified plankton tow) (section 5.9(b)(6)); (2) why evaluating fish food resources in still water habitats requires sampling aquatic plants (section 5.9(b)(4)); or (3) why this additional sampling is necessary to meet the information needs of the river productivity study (section 5.9(b)(7)).

Given the frequency and distribution of sloughs and tributary mouths at AEA's proposed study stations in the Middle River and Lower River,[54] and that AEA proposes to collect 5 replicates of each benthic sample taken, we consider sampling at one transect with 5 replicates, in each of these macrohabitat types,[55] to be sufficient to discern differences among macrohabitats, and support an analysis of potential project effects on fish food resources (section 5.9(b)(5) and (6)). We estimate the cost of sampling at one transect with 5 replicates, to be $25,000 (section 5.9(b)(7)).

We recommend that AEA sample invertebrates in the water column and the water surface of still water areas in one side slough, one upland slough, and one tributary mouth (if present) at each study station in the Middle River and Lower River using a modified plankton tow or similar sampler. Five replicates should be collected along a single transect at each site.

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[54] Tributary mouths and side sloughs or upland sloughs are present at four of the five proposed study stations.

[55] All four of the proposed sampling stations in the Middle River and the one proposed sampling station in the Lower River have tributary mouth macrohabitats; three of the five sampling stations have side sloughs; and three have upland sloughs. Sampling in each of these three macrohabitat types, where present at each station, would result in 11 samples.

Organic Matter Sample Processing

In their March 18, 2013 comments, NMFS and FWS state that the generally accepted practice of the scientific community is to obtain ash free dry mass (AFDM)[56] from samples of benthic and transported organic matter. They state that this method identifies the portion of the organic matter that is a carbon food source and eliminates error caused by fine inorganic particles that cannot be easily removed from the sample. The agencies request that AEA combust dried benthic and transported organic matter samples to obtain AFDM using methods defined in *Standard Methods for the Examination of Water and Wastewater, 22nd edition*.

Discussion and Staff Recommendation

AEA proposes to obtain AFDM from algae samples in keeping with standard scientific practice, but proposes to measure biomass of organic matter samples by oven drying to constant weight. AFDM is the generally accepted method within the scientific community for measuring biomass from many types of samples, including organic matter (section 5.9(b)(6)). We note that oven drying is a prerequisite process for samples that are combusted to determine AFDM, thus AEA could record the oven-dry weights of the organic matter samples, if needed, prior to combusting them without compromising the samples for measurement of biomass using AFDM. We the estimate the cost of this additional sample processing to be $5,000 (section 5.9(b)(7)).

Therefore, we recommend that AEA obtain AFDM measures of biomass from samples of benthic and transported organic matter, using generally accepted scientific methods (section 5.9(b)(6)).

Benthic Macroinvertebrate Sampling on Snags

In their March 18, 2013 comments, NMFS and FWS note that AEA's study proposal for sampling benthic macroinvertebrates (BMI) on woody snags is biased toward woody debris that is easily transported (small) and less likely to be colonized by invertebrates. The agencies state that AEA's proposed methods would not provide a measure of the relative abundance of woody debris within a sample area.

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[56] 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) (Steinman and Lamberti, 1996).

Accordingly, the agencies request that AEA inventory each sample site for large woody debris (LWD) (>10 cm in diameter and 1 m in length). The agencies request that AEA collect BMI samples from LWD by dislodging insects by hand and collecting organisms in a D-frame net as they are transported downstream, and suggest that the area of LWD sampled can be estimated by the diameter and length of surface disturbed.

Discussion and Staff Recommendation

AEA's Study 9.9 (aquatic habitat mapping) includes "wood" as a metric to be recorded.[57] As such, LWD would be inventoried by AEA within the focus areas. In its RSP for Study 9.9 (aquatic habitat mapping), AEA indicates that the habitat mapping results would be used in Study 9.8 (river productivity) for identification of study site selection and quantification of habitat types for interpolation. We therefore conclude that an inventory of LWD presence would occur as the agencies have requested.

AEA proposes to sample BMI from smaller pieces of LWD that can be easily removed from the water. AEA's proposed methods would not assess BMI abundance on embedded LWD or large pieces of LWD that are more likely to become immobile and thus colonized and used as a substrate and/or food source by BMI, as requested by the agencies.

LWD is used by aquatic macroinvertebrates as both a substrate and a food source. It can be an important habitat for some taxa along channel margins and at point bars in large rivers with unstable beds (Wallace and Anderson 1996). The presence of the proposed dam would likely reduce the fluvial transport of LWD from the upper Susitna

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[57] Throughout its RSP and implementation plans, AEA uses the terms "*snags*," "*wood*," and "*large woody debris*" interchangeably. However, the RSP includes two differing definitions for *LWD* and one for pieces of *snags* to be sampled for BMI (e.g., "*LWD must be at least 0.1 meter (4 inches) in diameter, and at least 1.0 meter (39 inches) of the LWD must be below the water's surface at bankfull flow"* and LWD are *"pieces of wood larger than 10 feet long and 6 inches in diameter, in a stream channel. Minimum sizes vary according to stream size and region"* and "*Snag pieces should be at least 5 centimeter in diameter, and up to a maximum diameter of 15 centimeter."*). For this determination, we refer to "*snags"*, and "*wood"* as large woody debris (LWD) and adopt the definition from AEA's RSP for Study 9.13 (aquatic resources within the access alignment, transmission alignment, and construction area): *LWD must be at least 0.1 meter (4 inches) in diameter, and at least 1.0 meter (39 inches) of the LWD must be below the water's surface at bankfull flow*. This is consistent with the agencies' definition.

River watershed and may also alter LWD recruitment in the Middle and Lower River segments (section 5.9(b)(5)). As stated by AEA in its RSP and RPIP, in rivers such as the Susitna River that are large, cold, and turbid during the growing season, secondary productivity is not likely to be driven by primary production or from the algal community within the system, but rather by inputs of organic material, such as LWD, from the terrestrial environment. As a result, assessing potential effects of the project on LWD and associated resources such as BMI, and secondary productivity is justified (section 5.9(b)(4) and (5)).

As suggested by the agencies, sampling BMI on large, immobile LWD could be accomplished by dislodging organisms by hand from a representative portion of the LWD, and collecting them in a net as they enter the water column. The surface area sampled in this manner should be calculated. This is a common method in the scientific community for sampling BMI from immobile LWD (section 5.9(b)(6)).

This type of sampling could be conducted in conjunction with AEA's proposed sampling of smaller more mobile LWD, and would eliminate any bias in size selection of woody debris for BMI sampling. AEA proposes to collect five replicate BMI samples on small and easily moved pieces or those removed from immobile LWD present at each sampling site (i.e., macrohabitat), and we recommend it also collect five replicate BMI samples from large, immobile LWD at each site. We estimate the cost of collecting and processing these additional samples to be $80,000 (section 5.9(b)(7)). Given the project will likely effect LWD fluvial transport and may also alter LWD recruitment and potentially influencing LWD as a source of organic material for secondary production in the Susitna River, we find this additional cost and effort to sample BMI from a range of LWD would represent this resource better (section 5.9(b)(7)).

Therefore, we recommend that AEA sample BMI on measured and representative portions of LWD *in situ* by dislodging organisms by hand and collecting them in a net as they enter the water column at each sample site.

For consistency, we also recommend that AEA use of the term "large woody debris" (LWD) as defined here: *"LWD must be at least 0.1 meter (4 inches) in diameter, and at least 1.0 meter (39 inches) of the LWD must be below the water's surface at bankfull flow"* and apply it consistently when referring to "wood" and "snags" in its RSP and future study reports.

Light Extinction Coefficients

In their March 18, 2013 comments, NMFS and FWS request that AEA measure photosynthetically available radiation (PAR) on each sampling date in deep still water portions of all macrohabitats at 10-cm depth increments to the stream bottom and use these data to calculate light extinction coefficients by fitting the relationship between solar radiation and depth using an exponential decay model.

Discussion and Staff Recommendation

AEA proposes to measure PAR at each benthic algae sample site (RSP section 9.8.4.4 and RPIP section 2.3). AEA states that PAR readings would be taken from just below the water surface to the stream bottom at regular 10-cm intervals (as requested by the agencies) and a turbidity measurement, using a portable turbidity meter, would also be taken at the sample site to determine water clarity. However, AEA does not propose to calculate the light extinction coefficients requested by the agencies.

The NMFS and FWS request does not explain the need for this additional information or how light extinction coefficients would inform an analysis of potential project effects, and does not explain why AEA's proposed methodology would not provide the necessary information to support the effects analysis (section 5.9(b)(4) and (7)). We therefore see no need for AEA to calculate light extinction coefficients.

No modifications to the study plan are recommended.

Emergence Sampling

In their March 18, 2013 comments, NMFS and FWS assert that AEA's proposed method to sample emergence of adult aquatic insects is limited to low velocity habitats and is proposed at only one macrohabitat type per study station, which NMFS and FWS contend limits the effectiveness of this method to address study objectives. The agencies contend that the study would be unable to document the differences in adult insect emergence as a function of temperature, which varies among macrohabitats. They request that AEA deploy one emergence trap in all available macrohabitats including tributary mouths (where possible), mainstem backwaters, and backwaters of side and upland sloughs.

The agencies observe that insect emergence begins prior to breakup, and contend that moving ice would likely destroy the samplers. The agencies request that AEA deploy the emergence traps in open water leads in late March and early April before ice breakup to document adult insect emergence coincidental with juvenile salmon emergence timing, remove the traps during ice breakup, then redeploy them following breakup in late May or early June, and finally remove the traps at the end of June. The agencies contend that collecting samples every two weeks, as proposed by AEA, would not provide an accurate measure of insect emergence timing and therefore request that AEA empty the traps weekly.

The agencies additionally state that the increased cost associated with deploying multiple samplers at each study station (i.e., in all available macrohabitats) would be offset by reducing the study duration from the entire summer to May through June, which would reduce the number of field sampling trips and the number of samples to process. The agencies propose conducting this study only at Middle River study stations to reduce transportation costs.

Discussion and Staff Recommendation

AEA proposes to sample emerging adult aquatic insects using floating emergence traps, within one main channel site and two off-channel sites at each study station in the Middle and Lower River segments. AEA also proposes to deploy additional emergence traps in slow water areas (beaver ponds, alcoves, backwaters) at each study station in the Middle River segment, if present. This sampling strategy would capture both fast-water (main channel) and slow-water (off-channel) habitats as requested by the agencies. While AEA does not propose to conduct emergence sampling in all available macrohabitats, as requested by the agencies, AEA's proposal would provide emergence data for a representative range of slow- and fast-water macrohabitat types, similar to that desired by the agencies.

We interpret the agencies' request that AEA collect the emergence samples on a weekly basis as an effort to better understand the timing of aquatic insect emergence as a function of water temperature in the Susitna River. However, we note that although many aquatic insect taxa in northern latitudes have highly synchronized periods of adult emergence (Butler 1984), even the shortest periods of emergence in Alaska rivers typically occur over a period of weeks rather than days (Moore and Schindler 2010). We also note that AEA proposes to record hourly water temperatures with submerged temperature loggers deployed at all sample sites throughout the ice-free season. Thus emptying emergence traps every two weeks, as proposed by AEA, would provide a measure of insect emergence timing that is sufficiently accurate to document the thermal drivers and temporal occurrence of emerging insects as a prey source for juvenile salmonids, and to assess potential project effects on this resource (section 5.9(b)(6) and (7)).

AEA's proposed sampling schedule for the river productivity studies specifies sampling from April through October in both study years (2013 and 2014). However, as indicated by the agencies, conducting the emergence sampling during ice break-up could result in the destruction of sample gear and the loss of valuable study data during April and May when coho salmon fry are emerging.[58] As such, timing of the insect emergence sampling should be coordinated with Study 7.6 (ice processes) to determine when samplers could be deployed in open water leads and when samplers should be removed to avoid ice breakup and then re-deployed, as suggested by the agencies (5.9(b)(6) and (7)). We estimate the cost of retrieving and redeploying the emergence samplers to be $40,000 (section 5.9(b)(7)).

Regarding the agencies' request that AEA conduct emergence sampling only through June, we note that AEA proposes to use the emergence data not only to assess the timing and abundance of emerging insects available as fish food resources, but also as a measure of aquatic insect production from the river and a surrogate measure of total aquatic insect production. As such, it is appropriate for AEA to conduct insect emergence sampling as proposed (April–October). This would ensure temporal overlap with the fry emergence periods of the target salmonid species and provide data necessary to document seasonal fish food resources and seasonal aquatic insect production.

Regarding the agencies' suggestion that AEA conduct emergence sampling only at Middle River study stations, we consider sampling at AEA's proposed Lower River station important to provide data on the potential for longitudinal changes in the effects of the project on insect emergence, productivity, and fish food availability. AEA's proposed study station in the Lower River segment is located below the confluence of the Chulitna and Talkeetna rivers, and would provide data to help assess the extent to which aquatic insect emergence, productivity, and fish food availability in the Susitna River may be altered by the influence of these major tributaries. Therefore it is appropriate that AEA conduct aquatic insect emergence sampling at each study station in the Middle River and Lower River segments, as proposed.

We recommend that AEA sample aquatic insect emergence in ice free areas, if available, beginning in April, then remove the traps during ice breakup and redeploy them following ice breakup in late May or early June.

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[58] According to AEA's life history summaries for the target salmonid species (RPIP section 1.3.2), coho salmon fry are thought to emerge from early March through May or later. Chinook salmon fry emergence is believed to be underway by April and largely complete by early July. Rainbow trout fry are thought to emerge from early July through mid-August.

Macroinvertebrate Colonization Sampling

In their March 18, 2013 comments, NMFS and FWS request that AEA conduct a limited winter macroinvertebrate colonization study to address short-term variations in discharge due to load following operations of the proposed project. NMFS and FWS request that AEA deploy a set of five Hester-Dendy samplers at the six study stations they requested for winter fish studies in their comments on Study 9.6 (middle and lower river fish distribution and abundance).[59] The agencies request that AEA remove the samplers following 2, 4, 8, and 16 days of colonization to determine if macroinvertebrates would rapidly colonize substrate submerged under the rapidly changing winter flows proposed by AEA.

Discussion and Staff Recommendation

AEA's January 2013 Open Water HEC-RAS Flow Routing Model report indicates that the lowest river stage under proposed project operations would be 2–3 feet greater during the winter than currently observed in normal water years without the project.[60] As a result, project operations would provide more continuously submerged substrate (a greater wetted width) in the winter, and therefore more winter BMI habitat, than is currently available in normal water years. Additionally, the report indicates that during winter and under the maximum load following scenario a 2–3 foot stage change (fluctuation zone) between the peak flow and the low flow would occur daily.

Given that the proposed project operations would result in more winter macroinvertebrate habitat than currently exists and the daily peaking operations would likely preclude macroinvertebrate colonization within the fluctuation zone (section 5.9(b)(4)), we find the agencies' request to document macroinvertebrate colonization rates during winter months to be unnecessary (section 5.9(b)(5) and (6)).

No modifications to the study plan are recommended.

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[59] In their comments on Study 9.6 (middle and lower river fish distribution and abundance), NMFS and FWS request that AEA move focus area 171 to a site that includes 4th of July Creek and the sloughs upstream, and move focus area 151 to a site in MR7, possibly near Lower McKenzie Creek or below Curry on old Oxbow II. NMFS also requests an additional focus area located in MR8 below Whiskers Creek and upstream of the three rivers confluence (RM 98.5).

[60] *See* Figure 5.4-17.

Trophic Modeling

In their March 18, 2013 comments, NMFS and FWS state that the proposed trophic modeling study would not likely provide results sufficient to evaluate the differences in fish growth potential and habitat quality among each of the five macrohabitats of the Susitna River. NMFS and FWS assert that this is a critical study objective for the development of project license recommendations. The agencies note that AEA's RPIP (section 2.7.3) states that growth rates would be stratified by "sampling period and reach." The agencies contend that, as a result, measures of growth rate would be applicable to the geomorphic reach scale and not to macrohabitat type, likely resulting in a large amount of variability in growth rates and a large range of variability in model output. NMFS and FWS request that AEA measure fish growth rates and production potential in each of the five macrohabitat types, and in the focus areas they recommend for the river productivity studies, to provide input data for trophic modeling.

NMFS and FWS contend that the proposed trophic modeling study design would produce results of questionable accuracy because AEA's approach assumes that fish growth occurs under a known temperature regime and food quality (i.e., the conditions where a fish is captured). However, the agencies note that fish are likely to migrate considerable distance during rearing and outmigration, and thus the water temperature and food quality conditions under which a fish actually grew may be unrelated to the conditions where it was captured and conditions were measured for the study. As such, the agencies request that AEA mark fish captured within each macrohabitat by fin clip or other method specific to the macrohabitat sampled so that growth rates can be representative of recaptured fish from within the habitat under investigation.

The agencies state that the accuracy of trophic modeling requires precise measures of growth rates by weight, and request that AEA weigh the first 50 fish captured of each species and age class to obtain length-weight relationships specific to each study station and macrohabitat, as proposed in their comments on the Fish Distribution and Abundance Implementation Plan (FDAIP).

<u>Discussion and Staff Recommendation</u>

AEA's study proposals, with the modifications we recommend for this study, include data collection (fish diet, fish scales, fish prey availability, fish prey quality (energy density), and water temperature) at five Susitna River study stations comprising 21 sites (macrohabitats) in the Lower and Middle River segments. While AEA states it would determine fish growth rates from seasonal mean weight at age data, as requested by the agencies, we note that RSP sections 9.5 and 9.6 (upper and middle river fish distribution and abundance) and the FDAIP contain no mention of fish weight measurement.[61] As such, it is unclear whether fish weight data would be collected as part of any of AEA's proposed studies. To provide the necessary data to: (1) develop length-weight relationships; (2) determine mean weight at age;[62] and (3) provide input to the growth rate potential models AEA proposes as part of this study, AEA should measure and weigh the first 50 fish captured of each target species and within each age class as part of Studies 9.5 and 9.6 as AEA suggests it will in Study 9.8.

We also note that AEA's trophic modeling study and implementation plan[63] do not specify the study stations or macrohabitats from which these data would be collected. To ensure that results enable comparative analysis of fish growth and growth rate potential among macrohabitat types, AEA should collect data for trophic modeling at all available macrohabitat types[64] in each Middle River and Lower River study station, consistent with our recommendation above in *Macrohabitat Replicates*.

Analysis of the fish, prey, and water temperature data collected at these 21 sites (macrohabitats) would allow comparisons of observed growth rates, estimated consumption rates, and estimated growth efficiency among the five different macrohabitat types and for each season the environmental conditions are observed during 2013 and 2014.

We note that due to movement of fish among habitat types and reaches, including movement from nursery tributaries to rearing areas in mainstem macrohabitats, measures of growth rate may be applicable to the geomorphic reach scale, as the agencies have indicated, and not to macrohabitat type. Marking fish captured for the trophic and growth

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[61] In its RPIP (section 2.10), AEA states that it would measure fish growth rate among different habitats under the environmental conditions observed during 2013 and 2014 using data from Study 8.5 (fish and aquatics instream flow), Studies 9.5 and 9.6 (upper and middle river fish distribution and abundance), and other components of Study 9.8 (river productivity).

[62] AEA proposes to determine fish age by analyzing scales.

[63] The RSP (section 9.8.4.8) and RPIP (section 2.10) for trophic modeling include growth rate analysis and bioenergetics modeling for coho and Chinook salmon and rainbow trout, and growth rate potential modeling for juvenile coho salmon and juvenile rainbow trout.

[64] Sampling in all available unique macrohabitat types at each of AEA's proposed Middle River and Lower River study stations would provide 21 sample sites.

modeling studies, as requested by the agencies, would indicate whether recaptured fish remained to rear and grow in the macrohabitat where they were initially captured, thus increasing the likelihood that growth rates can be determined for specific macrohabitats.

At each site (macrohabitat) sampled, AEA could mark the first 50 fish captured of each target species and age class to enable identification of individual fish upon recapture. These fish would be measured and weighed for growth studies as described above, and marked using PIT tags or subcutaneous dye injection to identify the sample site (macrohabitat) and date of capture. Growth of fish marked and recaptured in the same macrohabitat site could then be attributed to the growth conditions (e.g., water temperature, food availability) the fish experienced in that macrohabitat. These data could then be used to validate AEA's proposed growth rate potential model; whereas, without this *in situ* data, the model could not be validated (section 5.9(b)(4) and 5.9(b)(6)).

However, growth of fish recaptured in a macrohabitat other than the one in which they were initially marked could not be attributed to macrohabitat-specific growth conditions, but the data would nonetheless provide information on fish movement to complement the fish movement data collected as part of Study 9.6 (middle river fish distribution and abundance). Failure to recapture or otherwise detect marked fish from within the same macrohabitats would also provide valuable data regarding recapture probability and site fidelity at the macrohabitat level. We estimate that these study modifications to provide macrohabitat-specific growth conditions and *in situ* data for model validation would cost about $60,000 annually[65] (section 5.9(b)(7)).[66]

Additionally, AEA's proposed foraging models would estimate a consumption rate based on stream flow, turbidity, and prey density input data. However, AEA's foraging models do not appear to consider flow velocity. Velocity is a key variable when considering prey capture success of foraging fish (Hill and Grossman, 1993) (section 5.9(b)(4)). AEA proposes to collect velocity data when conducting its drift sampling efforts. Because velocity directly affects prey capture success of foraging fish, the

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[65] If after the first year of study it is apparent that fish movement among habitat types and reaches, severely limits the recapture rate of marked fish from within the macrohabitat initially marked, then marking of fish for the growth analysis study would not need to be conducted during the second year of study (2014).

[66] This cost estimate assumes PIT-tagged fish for study 9.6 at focus areas 104 and 141 (9 of the total 21 sites) would be able to serve a dual purpose, providing abundance and movement data for study 9.6 and macrohabitat growth data for study 9.8.

velocity data should be incorporated into AEA's foraging models to account for associated capture efficiency and the influence flow velocity would have on consumption rates. Because flow velocity data are being collected for drift sampling efforts, the additional costs should be nominal if capture efficiency estimates are available from the literature.

We address the agencies request that AEA conduct fish growth and trophic modeling studies in their requested focus areas above in *Modified Sampling Stations*.

In consideration of the above, for fish sampled for use in the growth and trophic modeling studies, we recommend that AEA measure, weigh, and mark the first 50 fish of each target species and age class captured within each sampled macrohabitat by PIT-tagging[67] to identify the capture station and date. We recommend that AEA collect fish for the trophic modeling studies at all available macrohabitat types (up to five per study station) in each Middle River and Lower River study station. Growth data collected from fish marked and recaptured in the same macrohabitat site should be used (if possible) to validate AEA's proposed growth rate potential model. We also recommend that AEA incorporate flow velocity into its foraging models and account for associated capture efficiencies when establishing consumption rate.

Stable Isotope Analysis

In their March 18, 2013 comments, NMFS and FWS assert that AEA's study plan lacks sufficient detail to determine if the study design is adequate to meet the study objectives. Specifically, the agencies note that AEA does not: (1) identify the two focus areas to be used for stable isotope sampling; (2) describe where within the focus areas the stable isotope samples would be collected; and (3) identify the number of adult salmon tissue samples that would be collected or where those samples would be collected.

The agencies state that the isotopic signature from the sampled organisms would likely vary depending on where samples are collected (e.g., side and upland sloughs vs. tributaries) due to spatial variability in habitat use by spawning salmon, the carcasses of which are the primary source of marine nutrients. The agencies express concern that the lack of specificity regarding the station of AEA's proposed study stations (i.e., focus areas) and sampling sites (i.e., macrohabitats) for the stable isotope analysis, relative to areas of high use by spawning salmon, would produce samples and results that are not

[67] PIT tags can generally be implanted in fish > 60 mm in length and a macrohabitat-specific subcutaneous dye injection should be used on fish less than 60 mm in length.

likely to be representative of the importance of marine nutrients to primary producers, macroinvertebrates, or juvenile fish throughout the Susitna River.

The agencies request that AEA: (1) increase the number of study stations in the Middle River segment; (2) collect samples for stable isotope analysis at each of their six requested focus areas in the Middle River;[68] and (3) conduct fish sampling for stable isotopes downstream from Indian River, at the backwater mouth of Slough 8A, downstream from Fourth of July Creek, at the confluence of Slough 6A, in the tributary mouth of Whiskers Creek, and mainstem habitats of Oxbow II or the mouth of Lower McKenzie Creek.

Discussion and Staff Recommendation

AEA proposes to collect samples for stable isotope analysis from two of the river productivity study stations (focus areas) in the Middle River segment, with three habitat-specific sampling sites per station, for a total of six sampling sites. AEA does not identify which two focus areas would be the subject of the stable isotope sampling or which macrohabitat types (sites) would be sampled.

The NMFS and FWS objective for this study is to understand the portion of the total fish production in the Susitna River that comes from carbon and macronutrients of marine origin. NMFS and FWS state that this information would be used to evaluate how changes in the timing, distribution, and abundance of carbon and nutrients transported from the marine environment to freshwater habitats by adult anadromous fish may influence the distribution and production of juvenile anadromous and resident fish. However, NMFS and FWS have not: (1) described how the proposed project may influence the timing, distribution, and abundance of carbon and nutrients transported from the marine environment to freshwater habitats; and (2) demonstrated a need for this additional information or how AEA's proposal is insufficient to inform an effects analysis of the proposed action (sections 5.9(b)(4), (5), and (7)).

Based on our review, 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 potential license requirements (section 5.9(b)(5)). We recognize, however, the stable isotope analysis would provide baseline information on

[68] Indian River (focus area 141), Slough 8A (focus area 128), Slough 6A (focus area 115), Whiskers Creek (focus area 104), Fourth of July Creek (requested new focus area near RM 131), and Lower McKenzie or Oxbow II below Curry (requested new focus area near RM 116 or RM 119).

the nutrients transported from the marine environment to freshwater habitats of the Susitna River. Given the limited use of the study data, AEA's proposed level of effort is reasonable to document baseline conditions and that AEA should consult with the agencies when identifying the appropriate two focus areas for sampling, where within the focus areas each type of stable isotope samples would be collected, and the number of adult salmon tissue samples to be collected.

We recommend that AEA consult with NMFS and FWS when identifying the appropriate two focus areas for stable isotope sampling, where within the focus areas each type of stable isotope samples would be collected, and the number of adult salmon tissue samples to be collected.

Talkeetna River Reference Study Station

In their March 18, 2013 comments, NMFS and FWS request to be consulted in the selection of appropriate reference stations on the Talkeetna River and to accompany AEA on field visits for final selection of the reference stations.

Discussion and Staff Recommendation

To assess the feasibility of the Talkeetna River as a reference site for post-project monitoring activities in the Susitna River, AEA proposes to select a study station in the Talkeetna River and conduct river productivity sampling as proposed for those in the Susitna River. Because habitat types have not been identified for the Talkeetna River, AEA proposes to select the Talkeetna River reference study station based on an initial review of topographic maps and available orthographic images. A final site would be selected during a site reconnaissance trip.

Consultation with the agencies when selecting the Talkeetna River reference study station is appropriate and consistent with the intent of the Commission's Integrated Licensing Process.

We recommend that AEA consult with the TWG when selecting the Talkeetna River reference study station.

Characterization and Mapping of Aquatic Habitats (9.9)

Applicant's Proposed Study

AEA proposes to conduct a study to characterize and map aquatic habitat in the Susitna River using a Susitna River-specific five-tier hierarchical and nested classification system. The mapping effort would be implemented differently within each of the following river segments and water bodies within those segments.

1) Combined Upper River segment (RM 233 to RM 184) and Middle River segment (RM 184 to RM 98.5) beginning at the Oshetna River confluence and continuing downstream to the three rivers confluence area.

2) Upper River and Middle River tributaries up to the upper limit of the project's zone of hydrologic influence within each tributary.

3) Upper River segment lakes that are within the proposed reservoir inundation zone.

4) Lower River from RM 98.5 to the upper end of tidal influence (about RM 28).

The study area for the mapping effort within Upper River segment tributaries would extend from the tributary mouth (i.e., confluence with the Susitna River) up to the 3,000-foot elevation, or up to the elevation of any permanent impassable fish passage barrier if one exists above the 2,200-foot elevation and before the 3,000-foot elevation.[69] The study area for Middle River segment tributaries extends from the tributary mouth up to the project's zone of hydrologic influence.[70]

AEA's proposed habitat classification system combines the historic approach used by the Alaska Department of Fish and Game (Alaska DF&G) during the 1980s studies (Alaska DF&G, 1983a) to map mainstem habitats with a modified version of the mesohabitat classification system from the U.S. Forest Service's (Forest Service) Aquatic Habitat Surveys Protocol (Forest Service, 2001). AEA indicates this hybrid classification system describes habitats that are defined by the unique hydrology of the Susitna River system, and are significant to the day-to-day function and behavior of fish and aquatic organisms.

AEA proposes to stratify the river according to the following five-tier hierarchical and nested classification scheme.

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[69] Aquatic habitat mapping efforts are completed from a downstream to upstream direction.

[70] The upper limit of hydrologic influence is not yet defined and RSP section 9.12.3 indicates that it would be determined from supporting studies such as Study 8.5 (fish and aquatics instream flow) and Study 6.5 (geomorphology).

- Level 1 divides the river into three major hydrologic segments (i.e., Upper River, Middle River, and Lower River segments).

- Level 2 divides the major hydrologic segments into distinct geomorphic reaches (i.e., 6 geomorphic reaches for the Upper River, 8 geomorphic reaches for the Middle River, and 6 geomorphic reaches for the Lower River).

- Level 3 divides the mainstem into the following macrohabitat categories: main channel, split main channel, braided main channel, side channel, tributary, side slough, upland slough, backwater, and beaver complex.

- Level 4 further divides level 3 main-channel macrohabitats into mesohabitat types: pool, glide, run, riffle, and rapid.

- Level 5 is a calculation of edge habitat that is made by doubling the estimated length of the mapped level 4 mesohabitat units and reported as length/mile.

Within river segments 1–3, aquatic habitats would be delineated and mapped to the 4th level (mesohabitat) of the classification scheme. Within river segment 4, aquatic habitats would only be delineated and mapped to the 3rd level (macrohabitat). AEA does not propose to map the Lower River segment downstream of RM 98.5 at a finer resolution than level 3 because of the river's large channel size, the complexity of the Lower River, and the limited diversity of macrohabitat types.

AEA proposes to stratify tributary channels (within level 3 above) using the following classification system.

- Chanel type: divides tributary reaches into three channel types based on the number of channels present (i.e., single, split, complex).

- Hydraulic type: divides channel types into the following flow types (i.e., fast water, slow water, off-channel).

- Mesohabitat types: further divides hydraulic types into mesohabitat types (i.e., falls, cascade chute, rapid, boulder riffle, riffle, run/glide, pool, beaver pond, alcove, and percolation channel).

The goal of the study is to characterize and map all aquatic habitats with the potential to be altered and/or lost as the result of reservoir filling, hydropower operations, and associated changes in flow, water surface elevation, sediment regime, and temperature. Study objectives for collecting baseline data vary depending on the nature of the potential project effects and location within the study area where the effects may occur.

Objectives for Upper River tributaries include:

1) characterize and map Upper River tributary and lake habitats to evaluate the potential loss or gain in available fluvial habitat that may result from dam construction and inundation by the reservoir; and2) characterize and map Upper River tributary and lake habitats to inform other studies including Study 9.5 (upper river fish distribution) and Study 9.8 (river productivity).

Objectives for the Upper River and Middle River mainstem segments vary depending on the river segment and include:

1) Characterize and map the Upper River mainstem from the dam site to the confluence with the Oshetna River:
    a. to provide baseline data for evaluating the potential loss or gain in accessible available fluvial habitat that may result from dam construction and inundation by the reservoir; and
    b. to inform other studies including Study 9.5 (upper river fish distribution), Study 9.8 (river productivity), and Study 9.10 (reservoir fish community).
2) Characterize and map the Middle River mainstem from the dam site downstream to the three rivers confluence area:
    a. to provide baseline data for evaluating the potential loss or gain in accessible available fluvial habitat that may result from flow regulation below the dam site; and
    b. to inform other studies including Study 9.6 (middle and lower river fish distribution), Study 9.8 (river productivity), and Study 8.5 (fish and aquatics instream flow).
3) Characterize and map the Lower River mainstem from the three rivers confluence area downstream to the upper limit of tidal influence:
    a. to provide baseline data for evaluating the potential loss or gain in available fluvial habitat that may result from flow regulation below the proposed dam site; and

b. to inform other studies including Study 9.6 (middle and lower river fish distribution), Study 9.8 (river productivity), and Study 8.5 (fish and aquatics instream flow).

Methods for mapping lower stream order tributaries that are not conducive to aerial video mapping (see RSP, table 9.9-2), and selection of Middle River tributary segments to be mapped, would be determined with input from the TWG prior to the 2013 field season.

Comments on the Study

Habitat Classification System

NMFS and FWS request that AEA adopt the habitat classification system proposed in table 1 of the NMFS March 18, 2013, comment letter on revised study plans. NMFS and FWS state that the habitat classes proposed by AEA do not identify areas of fish segregation, are not hierarchical, and are not easily identified visually.

Discussion and Staff Recommendation

The classification system recommended by NMFS and FWS is a four-tier system based on level 1 geomorphic reaches; level 2 macrohabitats (i.e., tributaries, mainstem main channel, mainstem side channel, mainstem side slough, etc.); level 3 mesohabitats (i.e., pool, riffle, run, meander margin, point bar, etc.); and level 4 microhabitats (i.e., depth, velocity, substrate, DO, vertical hydraulic gradient, pH, dissolved organic carbon, invertebrate drift density, benthic organic matter, algal biomass, chlorophyll-a, etc.)

Based on our review of the agencies' classification system, we identify the following notable differences between the agencies recommended classification system and the classification system proposed by AEA.

1) The agencies recommend that all mainstem main channel and side channel habitats be further delineated to include classification of meander margins, backwater pools, and point bars, whereas AEA does not propose to characterize these features within its mesohabitat classification scheme.

2) The agencies recommend that both slough types (i.e., upland and side sloughs) be further delineated into additional mesohabitat types such as slough mouths, slough scour pools, and slough riffles, whereas AEA does not propose to delineate and map all slough habitats into mesohabitat features.

3) The agencies recommend that AEA further stratify mesohabitats into another classification level that represents microhabitat features, whereas AEA does not propose to map the entire study area down to the microhabitat level.

AEA's classification system is not as comprehensive in nature as the agencies' recommended system, primarily in that it does not include mapping all macrohabitat features (i.e., sloughs) to the mesohabitat level, nor does it include mapping the entire project area down to the microhabitat level. However, the agencies do not provide any specific information on how this extremely fine-scale level of stratification could reasonably be applied to the extensive study area for the proposed project. Further, we are not aware of any instances where it would be necessary to stratify an entire project area spanning about 200 river miles to the microhabitat level in order to be consistent with scientifically accepted practices (section 5.9(b)(6)), or to adequately evaluate the effects of a hydropower project (section 5.9(b)(5)).

AEA's classification system is specific to the Susitna River and meets the intent of a nested hierarchical classification system at levels 1–4 (i.e., upper levels set bounds on lower levels, and lower levels characterize the range of conditions within upper levels), and therefore, is consistent with generally accepted practices in the scientific community (5.9(b)(6)).

No modifications to the study plan are recommended.

Mainstem Habitat Classes

NMFS and FWS state that AEA's level 3 mainstem habitat classification results in too many habitat classes, limiting adequate replication. NMFS and FWS state that AEA's proposed level 4, split main channel and braided channel habitat types[71] are a geomorphic classification and do not provide habitat characteristics or values that should be distinguished at the macrohabitat level.

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[71] We note that AEA uses the terms braided channel and multiple split main channel habitat types synonymously to describe macrohabitats with more than three dominant channels, leading to confusion. The term braided channel was used in the Draft RSP (Table 9.9-4), and the term multiple split main channel was used in the RSP (Table 9.9-4). In addition, the term braided main channel is used elsewhere in the RSP (e.g., RSP section 8.5.4.2).

Discussion and Staff Recommendation

AEA defines split main and multiple split main habitat types as having dominant flow in more than one channel, which differs from a main channel with a side channel because the side channel does not exhibit dominant flow. Stream channels with multiple dominant subchannels generally have increased sediment storage and retain smaller substrate than stream channels absent of subchannels. Because streambed characteristics and substrates are an integral part of habitat classifications, AEA's proposed main channel habitats and classification scheme are reasonable to adequately consider these characteristics in the various study components (e.g., geomorphology modeling). Additionally, relative differences in depth and velocity characteristics, flow path complexity, and margin areas are expected among main channel, split main channel, and multiple split main channel habitat types. For these reasons, dividing the main channel habitats into five main-channel habitat types is consistent with generally accepted practices (section 5.9(b)(6)) and would support a higher resolution of the analysis of project effects (section 5.9(b)(5)).

If the initial results of the 2013 studies indicate that meaningful differences are not evident in the mesohabitat composition within main channel, split main channel, and/or multiple split main channel habitat types, and it is apparent that there are too many habitat classes to provide adequate replication of each macro- and mesohabitat type, AEA could propose or the agencies could recommend that the subdivisions be removed for future sampling efforts and analysis (sections 5.15(c)(2) and 5.15(c)(4)).

No modifications to the study plan are recommended.

Edge Habitat

NMFS and FWS state that AEA's level 5 delineation of edge habitat is not a distinct habitat type and that stream meander margins include a wide variation in physical habitat characteristics that are not captured by AEA within this classification type.

Discussion and Staff Recommendation

As proposed by AEA, edge habitat is a simple mathematical calculation based on a doubling of habitat unit length that AEA states would be used as an indicator of channel complexity (reported as miles of edge habitat per mile).[72] This calculation would provide

[72] Table 7, Middle River Segment Remote Line Habitat Mapping Technical Memorandum, January 2013.

little useful information on habitat complexity or other habitat characteristics, and its inclusion as level 5 of the classification scheme would not be necessary for aquatic habitat delineation, sample site selection, or extrapolation (section 5.9(b)(6)).

We recommend that AEA remove the level 5 calculation of edge habitat from the habitat classification system.

Microhabitat Classification and Fish Use

NMFS and FWS state that the current classes of habitat proposed by AEA and reported in the RSP do not identify areas of fish segregation. EPA and Coalition for Susitna Dam Alternatives state that channel planform[73] may not be a good predictor of microhabitat conditions, and suggest testing such relationships.

NMFS and FWS state that the microhabitats of meander margins become more important as unique habitats in large rivers where they represent an area distinguished by lower velocities and greater cover when compared to the channel thalweg.

Discussion and Staff Recommendation

It is our understanding that these comments relate to the classification of microhabitats for the purpose of developing an understanding of the fine-scale habitats that are important to fish, and how these habitats may change under a managed flow regime.

Microhabitats are located within mesohabitats and are defined by a suite of other fine-scale habitat characteristics (e.g., depth, velocity, substrate, cover). Microhabitats are not included in AEA's habitat classification system because they are not used to stratify channels in the study area. Instead, AEA proposes to assess physical or chemical microhabitat characteristics and their relationship to fish use and segregation through development of habitat suitability criteria (HSC) and a habitat suitability index (HSI) for these characteristics for target species and life stages as part of Study 8.5 (fish and aquatics instream flow). The HSC/HSI would be used in one- and two-dimensional hydraulic models, and other habitat-specific models (e.g., varial zone model), to define the distribution and abundance of microhabitat conditions determined to be important to

[73] Channel planform refers to the channel pattern looking down from above, also sometimes described as plan-view or map-view. Planform is common to geomorphology in describing channel characteristics at a moderate scale. The degree of channel sinuosity would be an example of a channel planform characteristic.

target species and life stages, develop species and life stage-specific flow-habitat relationships, and assess how habitats may change as a result of various operating scenarios. This is a reasonable and proven approach that would provide the information necessary to describe the existing environment and evaluate project effects on fish-habitat relationships at the microhabitat scale (section 5.9(b)(5)), and is an approach that is consistent with generally accepted practices in the scientific community (section 5.9(b)(6)).

No modifications to the study plan are recommended.

Consistency among Study Sections

NMFS and FWS state that habitat classification is not consistent among studies such as Study 9.8 (river productivity), Studies 9.5 and 9.6 (fish distribution and abundance), and Study 8.5 (fish and aquatics instream flow).

Discussion and Staff Recommendation

Although we find a number of inconsistencies in the terminology used in the RSP,[74] we believe that these inconsistencies are oversights and understand that AEA proposes to use the same two classification systems across all studies, as applicable (i.e., five-tier classification system applied to mainstem habitats, and a tributary classification system to describe tributary habitats).

No modifications to the study plan are recommended.

Backwater and Beaver Dam Habitats

NMFS and FWS state that backwaters and beaver dams are not unique flow types, but are nested within the other macrohabitat classes.

Discussion and Staff Recommendation

It is our understanding that the agencies are stating that backwater and beaver dam habitats, which are currently categorized within level 3 (mainstem habitat) in AEA's classification system, would be more appropriately categorized within level 4 (main channel and tributary mesohabitats).

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[74] Examples of inconsistent terminology found include the use of mainstem instead of main channel, and the use of braided main channel instead of multiple split main channel as previously noted.

Both beaver complex and backwaters describe habitat conditions at the mesohabitat scale (e.g., pool, riffle, run), rather than the coarser macrohabitat scale (e.g., main channel, side channel, side slough); therefore, it would be appropriate to categorize both of these habitat types as level 4 mesohabitats. This is common practice in the scientific community (section 5.9(b)(6)), and similar to how these types of habitats are treated in AEA's tributary classification system.[75]

Additionally, we note that AEA's classification of a clearwater plume is level 3, but for similar reasons as discussed above, this habitat type is more appropriately classified in level 4 (main channel and tributary mesohabitats).

We recommend changing the classification of backwater, beaver complex, and clearwater plume habitats from level 3 (mainstem habitat) to level 4 (mainstem and tributary mesohabitats).

Classification of Upper River Tributaries

NMFS and FWS state that current survey methods are biased toward mainstem and larger tributaries in the Upper River due to the lack of visibility through riparian vegetation on smaller tributaries.

Discussion and Staff Recommendation

The use of aerial imagery as a sole remote mapping technique would typically under-represent small and low-order tributaries due to vegetative cover, as indicated by NMFS and FWS. In the RSP, AEA states that, in addition to the 14 large Upper River tributaries listed in Table 9.9-2, habitat in small and low-order tributaries would also be mapped. AEA proposes to use desktop tools to classify Upper River tributaries into geomorphic reaches based on gradient, confinement, and hydrology. A subsample of geomorphic reaches would be selected for ground-mapping based on access (helicopter and foot), and the availability of multiple and varied mesohabitat types. However, other than noting that the need and method for mapping smaller tributaries would be determined with input from the TWG prior to the 2013 field season, AEA provides no specific information on the number of reaches or replicates proposed, or an approach to determine an appropriate sample size for these smaller tributary sites. We therefore have insufficient information to conclude whether AEA's proposed methods would provide the information necessary to quantify and evaluate project effects on the smaller Upper River

[75] See Characterization and Mapping of Aquatic Habitats, RSP section 9.9, Table 9.9-3.

tributaries that would be permanently modified by project construction and reservoir inundation (section 5.9(b)(6)).

We recommend that AEA consult with the TWG and file no later than June 30, 2012, the following information to quantify small and low-order tributaries in the Upper River study area:

1) A detailed description of the specific methods to be used for selecting a representative sample of small and low-order Upper River tributaries for aquatic habitat mapping.

2) Documentation of consultation with the TWG, including how its comments were addressed.

Habitat Mapping at Multiple Flows

NMFS and FWS state that the areas of macrohabitat and mesohabitat classes are flow-dependent and should be mapped under multiple flow conditions. They suggest that initial 2012 study results underestimate backwater habitat and preclude mesohabitat classification in side and upland sloughs due to flow conditions during surveys. NMFS and FWS also state that AEA's initial habitat classification is clearly based on water surface characteristics; therefore, classification is flow dependent and surveys or field measures must be conducted under multiple flow conditions.

Discussion and Staff Recommendation

In addition to the 2012 study data, AEA proposes to map habitats during the 2013 and 2014 field seasons under low-to-moderate flow conditions. Mapping of aquatic habitats under these flow conditions provides a better opportunity to observe underlying bedforms and an understanding of their influence on habitat and flow characteristics.

Study data collected in 2012, 2013, and 2014 would be used to evaluate resultant habitat conditions under a range of flows (low-to-high) through one- and two-dimensional modeling. These models, when properly calibrated, are able to accurately describe the lateral extent of surface flow, over a wide range of flows, to quantify and estimate the associated change in habitat area. AEA's proposed methodology to map habitat during low-to-moderate flows and to model habitat conditions under a range of flows is standard practice, and AEA's approach conforms to acceptable scientific methods and is consistent with generally accepted practices in the scientific community (section 5.9(b)(6)).

AEA appears to define backwater habitats differently than NMFS and FWS,[76] and therefore, it appears as though the backwater habitats defined by the agencies would not be captured as a unique habitat type by AEA's proposed classification scheme.

We agree with the agencies that backwater habitats (as defined by NMFS and FWS) likely provide unique habitat characteristics that are important to fish. However, because backwater habitats (as defined by the agencies) would likely be much more flow-dependent when compared to other mesohabitat types within level of 4 of AEA's proposed classification scheme, it does not appear to be appropriate to include them as a mesohabitat type for the purposes of the aquatic habitat mapping study (i.e., some of the backwater habitats would disappear under low-flow conditions, whereas riffles, runs, and pools would remain). Nevertheless, backwater habitats as defined by the agencies would likely provide valuable and unique habitat for fish, and these unique habitat characteristics should be delineated and applied to the evaluation of project effects on aquatic resources of the project area (section 5.9(b)(5)).

A reasonable approach for evaluating project effects on these unique backwater habitats would be to evaluate the confluences of side-channel and other off-channel habitats with the main channel of the Susitna River within instream flow study areas to determine how the habitats and associated fish use would change under various operating scenarios. This would be a relatively low-cost measure (section 5.9(b)(7)) because AEA is already proposing to conduct extensive evaluations of channel geometry, geomorphology, and flow conditions using field data collection techniques and both one- and two-dimensional modeling in the Middle River and Lower River study areas.

We recommend modifying the study plan to have AEA identify and give specific consideration to backwater habitats, as defined by the agencies (i.e., the confluence of off-channel habitats with main channel habitats), as a unique habitat feature and ensure a representative subsample of these locations when selecting transect

[76] AEA defines backwater habitat as "Found along channel margins and generally within the influence of the active main channel with no independent source of inflow. Water is not clear." NMFS and FWS define backwater (i.e., mainstem and side channel backwater pools) as "Slow water habitats that form due to mainstem backwater up [to] abandoned or active side channels separated from the midchannel by a visible current shear line. Water depth and velocity controlled by mainstem water surface elevation. Water physical and chemical characteristics reflect those of the dominant mainstem flow, however, the reduction in surface slope could increase sediment and organic matter deposition." In addition, NMFS and FWS have a separate definition for "tributary mouth backwater" habitats.

locations for one-dimensional or two-dimensional aquatic habitat modeling within Middle River and Lower River instream flow study sites.

Classification of Middle and Lower River Tributaries

NMFS and FWS state that Middle River and Lower River tributaries should be classified geomorphically because this level of classification distinguishes areas of salmon spawning and rearing distribution.

Discussion and Staff Recommendation

AEA proposes to classify habitat in Middle River tributaries only within the zone of hydrologic influence where proposed load-following operations would affect the lower reaches of the tributaries. AEA does not provide a description beyond its proposed habitat classification system regarding reach-level characteristics that may be included in mapping tributary habitat within this zone (i.e., single, split, complex).

For Middle River tributaries within the zone of hydrologic influence, it would be useful for AEA to report general tributary reach characteristics, such as tributary basin drainage area (a surrogate for channel size) and channel slope. These characteristics would provide a general understanding of channel size and configuration, in addition to the relative value to fish and aquatic resources, which would be necessary to describe the existing environment for affected tributaries and conduct the required analysis of project effects (section 5.9(b)(5)). We envision that this would be a relatively low-cost desktop analysis using GIS tools (section 5.9(b)(7)).

For Lower River tributaries, AEA does not appear to propose any mapping of aquatic habitat within Lower River tributary habitats in 2013. Instead, it proposes to identify and define habitat characterization objectives for the Lower River after a review of the 2012 study results. If the results of the 2012 and 2013 study results in the Middle River and Lower River (as documented in the initial study report) indicate that the project would cause significant adverse effects on tributaries within the Lower River zone of hydrologic influence, additional tributary mapping efforts could be added downstream in 2014 or in subsequent study years (sections 5.15(d) and 5.15(e)).

We recommend modifying the study plan to have AEA classify Middle River tributary reaches within the zone of hydrologic influence into geomorphic reaches based on tributary basin drainage area and stream gradient to provide a general understanding of the relative potential value to fish and aquatic resources, and report on these attributes in the initial and updated study reports.

Habitat Mapping and Ground-Truthing

NMFS and FWS request that off-channel mesohabitats be classified by helicopter video surveys, and that ground-truthing of video classification should be done in all focus areas. NRDC supports conducting ground-truthing surveys to reduce potential misinterpretations or omissions from the initial 2012 mapping effort. Additionally, NMFS and FWS identify potential discrepancies in 2012 habitat mapping results at focus area 104 (Whiskers Slough).

Discussion and Staff Recommendation

AEA performed initial habitat mapping in 2012 based on aerial photos and videography, and proposes to ground-truth all habitat mapping in focus areas, which would be consistent with FWS' and NMFS' requests.[77] Ground-truthing would presumably cover the full extent of aquatic habitats in all focus area, including focus area 104 (Whiskers Slough), and is intended to correct any misinterpretations or omissions from the initial 2012 mapping effort.

An additional requirement could be added to the study plan requiring AEA to provide the initial results of its 2012 and 2013 habitat characterization and mapping efforts. This would be a low-cost reporting requirement that would provide the agencies and other licensing participants the opportunity to review the initial habitat mapping efforts, and would help ensure that the mapping was completed consistent with scientific practices (section 5.9(b)(6)) as well as the study objectives (section 5.9(b)(1)).

We recommend that AEA provide a detailed description of methods and results of 2012 and 2013 habitat mapping in the initial study report, including a complete set of photographic base maps delineating macrohabitats (level 3) and mesohabitats (level 4) for all mapped locations.

[77] See Technical Memorandum, Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014 (March 2013).

Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam (11.6)

Applicant's Proposed Study

AEA proposes to identify, characterize, and map existing riparian vegetation, wetlands, and wildlife habitat types in riparian areas along the Susitna River downstream from RM 184 to RM 75. Information gathered from this study would be used to support the development of a spatially-explicit model to predict potential changes on downstream riparian floodplain vegetation due to project modifications of flow, sedimentation, groundwater, and ice processes.

General study objectives include the following:

1) Identify, delineate, classify, and map riparian ecotypes, wetlands, and wildlife habitats downstream from the proposed Watana dam site;

2) Characterize the role of erosion and sediment deposition in the formation of floodplain surfaces, soils and vegetation using a combination of stratigraphic descriptions, sieve analysis, and several complimentary sediment dating techniques;

3) Quantify and describe Susitna riparian vegetation communities using a combination of basic statistical summaries (e.g., basal area, density, stand age) and multivariate statistical techniques (e.g., cluster analysis, ordination, sorted tables), which would be used to develop a series of conceptual models of floodplain vegetation; and

4) Coordinate closely in the implementation of the riparian instream flow, groundwater, ice processes, and fluvial geomorphology studies to provide necessary and complimentary data, including vegetation successional models and mapping in support of a spatially-explicit model (to be developed in Study 8.6 (riparian instream flow)).

AEA would use an Integrated Terrain Unit (ITU) mapping approach to map landscape elements.[78] The ITU approach would map terrain units based on vegetation

[78] ITU is a multivariate mapping process in which terrain unit map boundaries are adjusted so that there is increased coincidence among the boundaries and occurrences of interdependent ITU variables, including hydrography, geology, physiography, soils, and vegetation units.

type, poplar size class (e.g., pole, timber, large timber), fluvial geomorphology, and surface-form types (macrotopography and microtopography), and then combine them into units with ecological importance. Also, Ecological Land Survey (ELS) plots would be used in the field to collect detailed data on site characteristics, environmental variables, successional vegetation, and soils. A series of maps would be produced, including maps of the individual terrain units (i.e., geomorphology, surface-form, vegetation type, and poplar size class), and maps of the aggregated terrain units (i.e., riparian ecotype, wetlands, and wildlife habitat).

Based on preliminary mapping of riparian ecotypes, wetlands, and wildlife habitats that was conducted in 2012, AEA proposes to develop a stratified random sampling scheme to select potential study plots within riparian habitats. The number of sample plots within each focus area would be determined by the total area of each focus area following the general rule of 1 plot for every 10 acres for focus areas up to 200 acres, and a maximum of 20 plots for focus areas greater than 200 acres. In addition to the stratified random sample, ELS plots sampled in the focus areas would be co-located with groundwater wells.

Sample plots along ITU and ELS transects outside the focus areas would be selected to cover the range of riparian habitats identified by photointerpretation. Based on preliminary mapping of riparian ecotypes and riparian process domains, which was completed in 2012, AEA would develop a stratified random sampling scheme to select potential study plots. The objective would be to sample multiple map polygons for each riparian, wetland, and wildlife habitat type, incorporating as much replication as possible within the time and funding constraints for the work.

The purpose of the ITU mapping plots is the rapid collection of the basic variables used in the ecotype classification and ITU mapping process. Hence the methods are designed to allow for efficiency in the field in order to cover a large area in a relatively short amount of time. Transects for the ITU plots would be oriented perpendicular to the Susitna River channel so as to cross various floodplain surfaces and patches of riparian vegetation in different successional stages. Five to ten circular plots of 10-meter (33-foot) radii would be sampled along each transect. The study plan provides a detailed list of variables to be recorded at each ITU mapping plot, including: (1) geo-referenced plot location (< 3-m accuracy); (2) site variables, including physiography, geomorphic unit, surface form, elevation, aspect, and slope; (3) vegetation structure and plant community composition; (4) drainage and soil moisture; soil hydrologic variables, including depth of water above or below ground surface, depth to saturated soil, pH, and electrical conductivity (EC); and soil depositional profiles; (5) wildlife sign; and (6) locations of tree ice-scars, ice bull-dozing, or other evidence of disturbance by ice (i.e., ice rafted boulders, etc.).

The purpose of the ELS plots are to facilitate the collection of detailed data on existing conditions (site characteristics, environmental variables, vegetation, and soils) for use in floristic, ecotype, and habitat analyses; sediment stratigraphy, aging, sieve analyses; and the development of vegetation successional models. They are also intended to serve as a baseline for possible long-term monitoring. ELS plots would follow a variable-sized plot design (3, 6.5, and 16.25 meter radius). The study plan details the sampling variables within each radius.

Comments on the Study

Study Area, Herbaceous Community Sampling, and Final Selection of Focus Areas and Sampling Sites

Because the riparian vegetation mapping and the riparian instream flow study are interrelated, FWS reiterates its concern for defining the lateral extent of the floodplain in consultation with the riparian technical working group, mapping herbaceous communities, and selecting final focus areas and sampling sites that include herbaceous and other underrepresented community types.

Discussion and Staff Recommendation

We address these comments in Study 8.6 (riparian instream flow) and do not repeat that analysis and staff recommendation here.

Sampling Scheme

FWS recommends AEA provide a figure showing the basic sampling scheme, including typical plant community polygons, physical features (e.g., channels), groundwater well locations, vegetation sampling transects, and sample plots. FWS recommends that stakeholders be allowed to review the specific sampling scheme for each focus area before the focus areas are sampled.

FWS recommends AEA define the stratification factors in the stratified random sampling scheme. FWS also recommends that AEA sample floodplain vegetation at all groundwater wells, recognizing these plots would not likely fit within a random sampling scheme.

For sample plots outside the focus areas, FWS recommends AEA define the ratio of the sample-intensive ELS plots to the less sample-intensive ITU plots. FWS recommends sampling as many field plots as practicable, particularly the ELS plots, and setting the minimum number of field plots by plant community type within each process domain rather than on the "time and funding constraints for this work" as proposed by AEA.

FWS agrees with adjusting the shape of ITU and ELS plot based on the shape of the plant community being sampled as proposed by AEA, but also recommends that AEA adjust the shape and/or location of the plots to minimize any trend in topographic elevation (i.e., slopes that would affect the depth to groundwater and surface-water flooding). FWS recognizes that some micro topographic variation is unavoidable for these larger plots, but the effect of micro topography should be minimized as much as possible when selecting plot locations where plant response would be linked to water levels.

Discussion and Staff Recommendation

The study does not need modification with regard to sampling vegetation at all groundwater wells because AEA has agreed to co-locate vegetation sampling plots with the groundwater wells as recommended by FWS.

We recommend that AEA also adjust the shape and/or location of the ELS and ITU plots to minimize any trend in topographic elevation as recommended by FWS. This would minimize confounding factors in the sample plots.

Although AEA has completed the preliminary vegetation mapping, it has not yet defined the stratified sampling design or identified the sampling plots. It proposes to do so in collaboration with the riparian technical working group.

Therefore, we recommend that AEA consult with TWG on the sampling design for vegetation sampling within and outside the focus areas, and file no later than June 30, 2013, the following information:

1) A detailed sampling design, including a schematic of the sampling scheme for each focus area, the stratification factors, and basis for the number of plots within and outside the focus areas.

2) Documentation of consultation with the TWG, including how its comments were addressed.

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