Fish monitoring plan for the Kvichak River RISEC Project (Igiugig)

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1.0 INTRODUCTION

The Federal Energy Regulatory Commission (FERC) process requires the preparation of a Pre-License Monitoring Plan for fish resources as part of a Draft License Application for a pilot hydrokinetic project. This plan describes the methods and activities to collect fish resource data relative to the operation of a RISEC device (River In-stream Energy Conversion, Appendix A) on the Kvichak River, AK, and identify any effects (positive, negative, indifferent) of the operation on the fish resource. The plan will be implemented upon operation of a RISEC device.

While the focus of this Plan is fish resources, available data regarding terrestrial and aquatic wildlife that could be encountered in the vicinity of the project is also provided (Appendix B). This data can be used to inform incidental environmental observations that can take place during fish monitoring operations and provide a context for potential impact assessment.

1.1 MONITORING PLAN NEXUS

This document describes a rationale for preparing the monitoring plan, the objectives of the plan, and how the objectives will be achieved. The issues, observations, and data required for this process are based on content as per FERC regulations §5.6(d)(3)(i), §5.6(d)(3)(iv), §5.11, §5.18(b)(5)(ii)(B), and §5.18(b)(5)(ii)(C). In addition, the information needs of ADF&G (Alaska Department of Fish & Game) to prepare a Fish Habitat Permit (FHP, Title 16 Permit) are considered as based on Durst (2011). The primary objective of the monitoring program is to document how migrating fish interact with and pass the RISEC devices.

The tasks to achieve the objectives include summarizing the existing fish resources of the Kvichak and their management, designing an appropriate data collection system to conduct the monitoring of fish passing in proximity to the RISEC devices, developing the methods of analysis and criteria by which to evaluate potential effects, and describing the potential impact of RISEC devices on the fish populations. Below we describe the methods to characterize fish and their behavior in proximity to the device(s). Monitoring activities are designed to observe downstream migrating anadromous juveniles, upstream migrating anadromous adults, and resident adults. All species of fish in close proximity to the device will be monitored, but we anticipate that salmon and trout will be of special interest given their relative abundance and distribution. The background documentation on existing resources and the methods of the monitoring plan are applicable to any of the potential hydrokinetic sites in the Igiugig vicinity. An implementation schedule, reporting schedule, regulatory agency comments (Appendix C) on the draft plan, and responses to comments on the plan (Appendix D) are provided.

1.2 STUDY AREA

The study area for this project centers on the Kvichak River at Igiugig, AK, although all fish resources of the watershed that could be impacted by a hydrokinetic operation at this location will be considered pertinent to assessments (Figure 1). More specifically, the primary focus will be on the waters immediately surrounding a RISEC device which we term the zone of influence (ZOI). The ZOI will extend to where fish can sense the device due to its structure or operation, or have an opportunity to encounter the device or its effected area. The ZOI will be qualified

through observation and inference. The broader watershed perspective will be used to context the localized project activities and effects.

The hydraulic and bathymetric characteristics of the Kvichak River at Igiugig are presented in TerraSond (2011). Site 10 or 11 is targeted for use in 2012 primarily for their suitable depth for the device deployment. Site 10 is approximately 6 m in depth and has a water velocity range of 1.8 to 2.0 m/s. Bottom composition at this site consists of small cobbles with very course, course, and medium gravel; there is no evidence of finer material (TerraSond 2011). Site 11 is 5 m in depth and has a water velocity range of 1.5 to 1.8 m/s. Bottom composition at this site consists of small cobbles with very course, course, and medium gravel; there is no evidence of finer material (TerraSond 2011). No direct observation assessment of fish habitat type is presently available, however we suspect that this site is relatively devoid of cover and used primarily as a movement corridor.

Other locations also have characteristics that may be suitable for hydrokinetic testing; these are sites 6 and 9. Site 6 is recommended as a preferred hydraulic location to operate a hydrokinetic device. Water depth is approximately 3 m, and water velocity ranges between 1.8 and 2.5 m/s. The river bed near Site 6 consists primarily of small cobble and coarse gravel with a small proportion of fines TerraSond (2011). Site 9 has a water depth of 4 m with water velocity ranges between 2.0 and 2.5 m/s. The river bed is composed mainly of small cobbles and very course gravel. The remainder of substrate consists of course, medium and fine gravel; there is no evidence of finer material (TerraSond 2011).

The Kvichak River at Igiugig is classified as Essential Fish Habitat (EFH) for anadromous fish by NOAA (2011a). There are no ESA (Endangered Species Act) fish or wildlife listed for this area (NOAA 2011b, USFWS 2011).

2.0 EXISTING FISH RESOURCES

2.1 SPECIES COMPOSITION

Fish species known to reside in the Kvichak River basin and have the potential to be observed in proximity to Igiugig are presented in Table 1. Each species has its own unique aspects of timing and behavior that influence the likelihood for encountering or being effected by a RISEC device(s). In general, fish that are found in the study area use this stretch of river as a corridor for migration to and from over-wintering grounds to their summer spawning and feeding grounds. Fish will locate themselves in the river according to preferred habitat characteristics such as water flow and food availability. Adult and juvenile fish tend to be located in environments where they have relatively low energy expenditure and high food intake. Therefore, typical preference in a river for holding or migrating is near the bottom, along the shores, and behind relatively large structures such as boulders. In this regard, adult fish will tend not to be in close proximity to hydrokinetic devices because they are located in the higher energy portion of the river. However, juvenile salmon will choose the high energy environments (surface, thalweg, no structure) where they can swim with the flow for downstream migration to the ocean and conserve internal energy. Juvenile salmon or other small migrating fish likely have a higher potential for encountering a hydrokinetic device. Further details are provided in later sections of this document for high priority species.

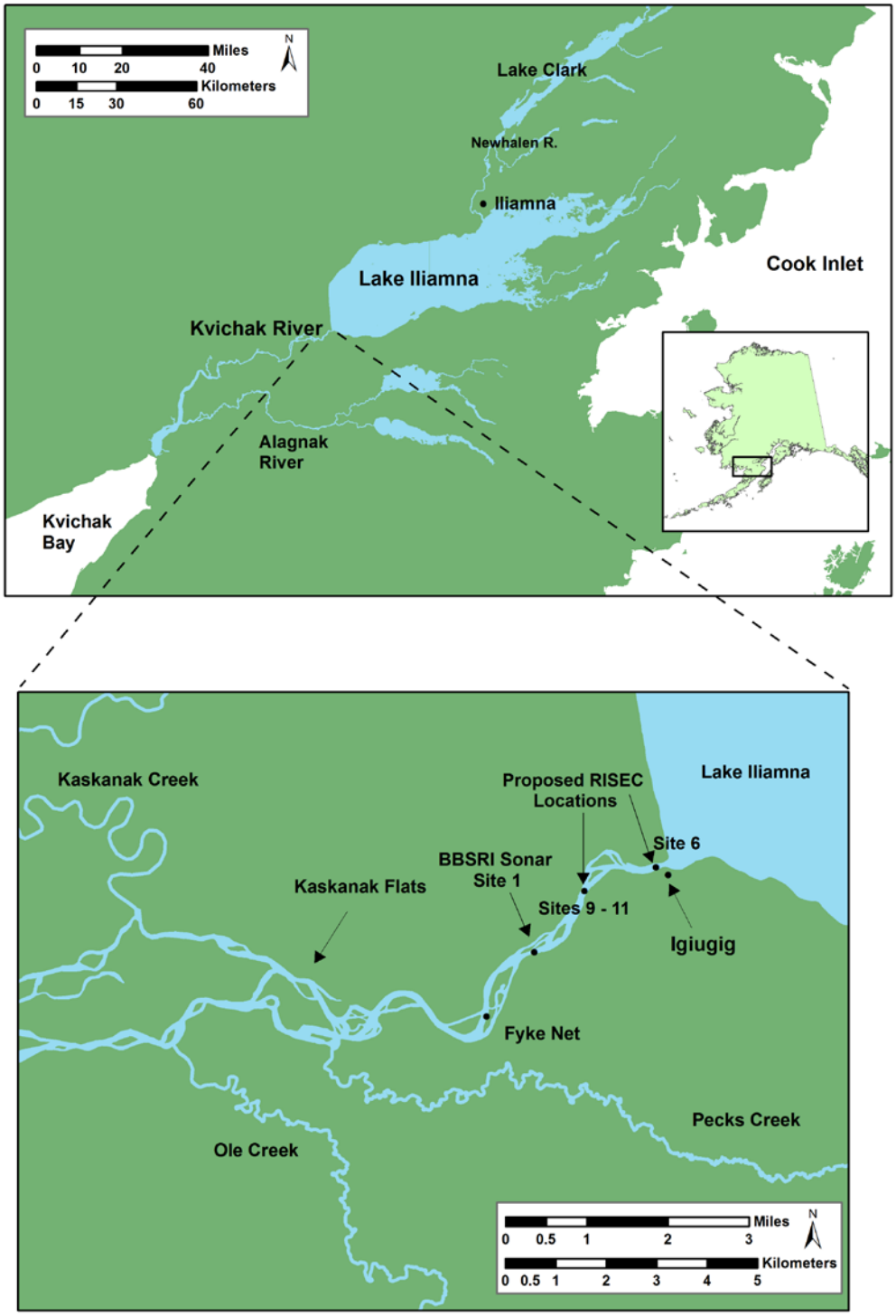


Figure 1. Kvichak River watershed and location of study area.

2.2 SUBSISTENCE FISH HARVEST

For the communities within the Kvichak River watershed, the subsistence way of life has always been a fundamental link to their cultural and physical wellbeing. Each year residents harvest, distribute, and consume many of the fish species that are found in the river (Table 1). Historically, salmon have been the mainstay for subsistence, but a considerable portion of the subsistence take is also comprised of non-salmon species that can be harvested year round. Recent studies estimate that greater than 18,000 lbs of non-salmon fish are harvested regionally on an annual basis (Krieg et al. 2005). Several different harvest techniques including angling and nets are employed as the fish move seasonally from their over-wintering grounds to summer spawning and feeding habitats (Fall et al. 2010).

Of the 16 different non-salmon fish used by the people of Igiugig, seven of these are estimated to be harvested by greater than 25% of the households in the village (Table 10 in Kreig et al. 2003). Rainbow, Dolly Varden, and Northern Pike comprise the species of greatest subsistence harvest, in descending order (Kreig et al. 2005). For the purposes of this study, we provide a summary of these seven species and describe how they utilize the habitat near the outlet of Lake Iliamna downstream to Kaskanak Creek (Figure 1).

Rainbow trout (*Oncorhynchus mykiss*) are the freshwater resident form of this species found in the Kvichak River watershed. The anadromous form (steelhead) have not been documented in the Bristol Bay region. During the spring, rainbow trout will congregate between the outlet of Lake Iliamna and Kaskanak Flat; these fish will include both spawners and nonspawners (Figure 1). Abundance studies by ADF&G were conducted during 1986 - 1991 near Igiugig (Minard et al. 1992). Much of the sampling for this study was conducted immediately below Igiugig in the braided portions of the river where the fish gathered in shallow, low velocity areas. The authors noted that rainbow trout gathered in large numbers at these sites during April and May. By mid-June, they disperse into Lake Iliamna to spend the summer months before migrating to tributaries of the lake and to the Kvichak River in the fall. Abundance estimates in 1988, 1989, and 1990 were 2,038 (SE=1,252), 2,912 (775), and 4,460 (1,441), respectively. Annual survival ranged from 28% to 30%, and average age was six years (Krieg et al. 2003, Mecklenburg et al. 2002, Minard et al. 1992, Morrow 1980).

The rainbow trout population supports a substantial sport fishing industry that is managed by ADF&G. In addition to being economically valuable to the residents of Igiugig, the rainbow trout are also a highly regarded subsistence resource. Krieg et al. (2003) reported that 100% of the households in Igiugig will include rainbow trout in their annual subsistence harvest. Local fishing guides indicate that rainbow can be located anywhere in the river, but that fishermen tend to run “lines” down the channel that are most productive (Brian Kraft, pers. comm., Alaska Sportsmans Lodge). These lines are defined by bathymetry, water flows, and food characteristics that are the most energetically beneficial to the rainbow. Depending on the type of hydrokinetic device deployed, it is possible that the structure may provide some preferred habitat (e.g., shelter or cover) for rainbow trout. This condition may encourage them to come in close proximity with the device even though the high power density region of the channel is not usually preferred. Overall, we anticipate that adult rainbow trout may encounter the hydrokinetic device and any in-water mooring or electrical cables running to shore.

Table 1. List of fish species in the Kvichak River.

Common name[a]	Scientific name	Subsistence	Use of study site[b]	Timing	Encounter Potential
Alaskan brook lamprey	*Lampetra alaskense*	No	Migrant	unknown	unlikely
Arctic-Alaskan lamprey	*L. camtschatica/alaskense*	No	Migrant	unknown	unlikely
longnose sucker	*Catostomus catostomus*	Yes	Migrant	Spring	unlikely
northern pike	*Esox lucius*	Yes	Migrant/Resident	Spring/Fall	unlikely
Alaska blackfish	*Dallia pectoralis*	Yes	non-typical	year-round	unlikely
rainbow smelt	*Osmerus mordax*	Yes	Migrant	Spring/Fall	unlikely
broad whitefish	*Coregonus nasus*	Yes	non-typical	Fall	unlikely
humpback whitefish	*Coregonus pidschian*	Yes	Migrant	Fall	unlikely
least cisco	*Coregonus sardinella*	Yes	Migrant	Fall	unlikely
pygmy whitefish	*Prosopium coulteri*	Yes	Migrant	unknown	unlikely
round whitefish	*Prosopium cylindraceum*	Yes	Migrant	unknown	unlikely
Arctic grayling	*Thymallus arcticus*	Yes	Migrant/Resident	Spring/Summer/Fall	unlikely
pink salmon	*Oncorhynchus gorbuscha*	Yes	Migrant	Summer	unlikely
chum salmon	*Oncorhynchus keta*	Yes	Migrant	Summer	unlikely
coho salmon	*Oncorhynchus kisutch*	Yes	Migrant	Summer/Fall	possible
rainbow trout	*Oncorhynchus mykiss*	Yes	Migrant/Seasonal	Spring/Fall	likely
sockeye salmon	*Oncorhynchus nerka*	Yes	Migrant	Spring/Summer	likely
Chinook salmon	*Oncorhynchus tshawytscha*	Yes	Migrant	Summer	possible
Arctic char	*Salvelinus alpinus*	Yes	Migrant/Seasonal	unknown	unlikely
Dolly Varden	*Salvelinus malma*	Yes	Migrant/Seasonal	Spring/Fall	possible
lake trout	*Salvelinus namaycush*	Yes	non-typical	year-round	unlikely
burbot	*Lota lota*	Yes	non-typical	year-round	unlikely
threespine stickleback	*Gasterosteus aculeatus*	No	Resident	year-round	possible
ninespine stickleback	*Pungitius pungitius*	No	Resident	year-round	possible
slimy sculpin	*Cottus cognatus*	No	Resident	year-round	unlikely

[a]Alt et al. 1994 a,b; Fall et al. 2010; Gryska 2007; Groot et al. 1991; Hauser 2007; Hubartt 1994; Krieg et al. 2003; Mansfield 2004; Mecklenburg et al. 2002; Minard et al. 1992; Morrow 1980; Quinn 2005; Salomone et al. 2009; Woody et al. 2007

[b] Migrant - utilize study site seasonally as a migratory corridor
Seasonal - May reside in study site
non-typical - rarely encontered in study site
Resident - Majority of life cycle could occur in study site

Arctic grayling (*Thymallus arcticus*) are found throughout the Kvichak drainage. During the winter months, grayling will be found in lakes or larger rivers that provide sufficient habitat while frozen. During the spring, they will migrate up streams to their spawning and feeding grounds, so the Kvichak at Igiugig is likely used only as a migration corridor rather than an area of residence. The grayling will spawn in low energy portions of the streams; this is also where the fry will rear before heading to the overwintering grounds. Grayling have been caught in the Kvichak at Igiugig, but the majority of this species are harvested further downstream near the outlet of Pecks, Ole and Kaskanak creeks (Gryska 2007, Krieg et al. 2003, Morrow 1980; Figure 1). No information on population abundance or cross-channel distribution at Igiugig is available, but based on their preferred habitat, we do not anticipate that adult or juvenile grayling will encounter the hydrokinetic device. However, they will likely encounter any in-water mooring and electrical cables running to shore.

Northern pike (*Esox lucius*) are found in the lakes and rivers throughout southwest Alaska, including the Kvichak. These fish will overwinter in the slower water of large rivers and deeper

lakes, and then migrate to their summer spawning and feeding grounds in slow moving streams, sloughs, and along the lake shore. The Kvichak at Igiugig is likely used only as a migration corridor rather than an area of residence because of predominant high water velocity. Residents of Igiugig will harvest pike in the Kvichak during the spring and fall (Alt 1994a, Krieg et al. 2003, Mecklenburg et al. 2002) in the Kvichak tributaries of Ole and Pecks creeks, and in Lake Iliamna tributaries of Upper and Lower Talarik creeks (Ida Nelson, pers. comm., Igiugig resident). No information on population abundance or cross-channel distribution at Igiugig is available, but based on their preferred habitat, we do not anticipate that adult or juvenile pike will encounter the hydrokinetic device. However, they will likely encounter any in-water mooring and electrical cables running to shore.

Humpback whitefish (*Coregonus pidschian*) can take advantage of many different freshwater and marine habitats and are found in freshwater residential or anadromous forms. These fish are found throughout the Kvichak River watershed and make up a large component of the subsistence fishery. Despite the relative importance of this fish, little is known of its life history or population size. A recent study by Woody and Young (2007) examined Strontium concentrations in humpback whitefish taken from Lake Clark and found no definitive evidence that those fish migrated to and from saltwater. It is known that spawning occurs during the fall and takes place in the upper reaches of streams, or the littoral zones of lakes. Based on harvest records for the people of Igiugig, humpback whitefish are caught near the village as they migrate to or from their spawning grounds located in the tributaries of the Kvichak River (Alt 1994b, Fall et al. 2010, Woody and Young 2007, Krieg et al. 2003). Residents fish for humpback whitefish in October and November (Ida Nelson, pers. comm., Igiugig resident). The Kvichak at Igiugig is likely used only as a migration corridor rather than an area of residence. No information on population abundance or cross-channel distribution at Igiugig is available, but based on their preferred habitat, we do not anticipate that adult or juvenile humpback whitefish will encounter the hydrokinetic device. However, they will likely encounter any in-water mooring and electrical cables running to shore.

Dolly Varden (*Salvelinus malma*) that are found in the Kvichak River watershed exist in anadromous or freshwater resident forms. Generally, the freshwater residents will be in the upper reaches of the streams that drain into Lake Iliamna, and the anadromous form is found in the mainstem and larger tributaries of the Kvichak River. Resident Dolly Varden will rear in slow moving water on the stream bottoms and then move to stream pools or eddies once they are large enough. Anadromous forms will spawn in the summer and fall and may remain in the streams up to 20 months before migrating back to the sea. The juvenile anadromous form will remain in the freshwater 2 to 4 years using the stream bottom for cover and a feeding. Once large enough, they make the transformation into smolts and migrate to sea around May and June (Hubartt 1994, Kreig et al. 2003, Mecklenburg et al. 2002, Morrow 1980). The anadromous form of this species is harvested January through April in the Kvichak (Kreig et al. 2005) via ice fishing. Local fishing guides indicate that Dolly Varden are caught incidentally when targeting rainbows, but are uncommon (Brian Kraft, pers. comm., Alaska Sportsmans Lodge). Overall, we anticipate that adult Dolly Varden may encounter the hydrokinetic device and any in-water mooring or electrical cables running to shore, but it would be a rare occurrence due to their low abundance in that particular area of the Kvichak River.

Longnose suckers (*Catostomus catostomus*) are harvested by residents of Igiugig during the spring, usually in late May and early June. These fish reside in lakes or stream pools and will migrate to gravel sections of streams in the spring for spawning. Based on the harvest records, the people from Igiugig harvest these fish in the feeder streams of the upper Kvichak, namely Pecks and Ole creeks, in addition to the Kaskanak Flats area (Krieg et al. 2003, Mansfield 2004, Mecklenburg et al. 2002, Morrow 1980; Figure 1). No information on population abundance or cross-channel distribution at Igiugig is available, but based on their preferred habitat, we do not anticipate that adult or juvenile longnose suckers will encounter the hydrokinetic device despite that they likely reside in the area. However, they will likely encounter any in-water mooring and electrical cables running to shore.

Rainbow smelt (*Osmerus mordax*) are anadromous fish that migrate up the Kvichak River each spring from the ocean and are thought to spawn in the tributaries of Lake Iliamna. Little is known about their life history or population size. However, based on traditional ecological knowledge, the rainbow smelt are only present from spring to early fall (Gotthardt and McClory 2006, Mecklenburg et al. 2002, Kreig et al. 2003). The Kvichak at Igiugig is likely used only as a migration corridor rather than an area of residence. No information on population abundance or cross-channel distribution at Igiugig is available, but based on their preferred habitat, we anticipate that out-migrating adult or juvenile rainbow smelt will encounter the hydrokinetic device and any in-water mooring or electrical cables running to shore.

2.3 ADULT SOCKEYE

2.3.1 Socioeconomic Importance

Bristol Bay, Alaska produces the greatest number of sockeye salmon (*Oncorhynchus nerka*) in the world. During 1991-2010, the region produced an average annual sockeye run of 38 million (standard deviation=12 million); the Kvichak stock represented 21% of this average. Bristol Bay sockeye have been intensively harvested since the early 1900s, mostly in commercial fisheries located in marine waters near river confluences (Clark et al. 2006). Commercial harvest from 1991 to 2010 averaged 26 million for the Bay as a whole and 4 million for the Kvichak.

Subsistence fishing for sockeye salmon in Bristol Bay has occurred since inhabitance and continues to be an important source of protein for local residents (Morstad et al. 2010). In 2009, the subsistence harvest of sockeye for the Kvichak River/Iliamna Lake sub-district totaled 46,772 from 187 permits, and in the Igiugig region totaled 1,071 from 5 permits (Salomone 2011). In addition to the subsistence fishery, sockeye salmon have been an essential segment of the sport fishing industry for that region. From 1997 – 2008 the annual sport fish harvest of sockeye in the Kvichak River averaged 1,860 fish (Dye and Schwanke 2009).

2.3.2 Management

In order to manage and sustain the fisheries, federal and state agencies have collected detailed records of catch, spawning escapement, and age composition for the nine major Bristol Bay sockeye stocks (including the Kvichak) since 1952. The Bristol Bay region remains relatively pristine, biodiversity of salmon populations remains high (Hilborn et al. 2003) and not been

influenced by hatcheries. Therefore, Bristol Bay provides a unique long-term history of wild salmon population dynamics, largely unaffected by habitat-altering factors and hatchery salmon.

Ultimate management authority for salmon fisheries in Alaska rests with the Commissioner of ADF&G. ADF&G's management objectives include: managing for sustained yield (largely accomplished by adhering to escapement goals); maintaining genetic diversity and overall health of the escapement (the number of fish that spawn each year); providing for an orderly fishery; helping to ensure high quality fishery products; and harvesting fish consistent with regulatory management plans. The commissioner delegates this authority to Area Management Biologists who regulate time and area openings for otherwise closed fisheries.

ADF&G's research biologists develop biological escapement goals for individual river systems based on sustained yield and/or maximum sustained yield principles using relationships between escapement levels and subsequent returns (termed stock-recruit analyses). Prioritizing escapement over allocation and economic objectives has contributed to managers' success in meeting river-specific escapement goals in most years (English et al. 2011).

2.3.3 Timing

Average run timing (2000-2010) shows that 25% of Kvichak spawners return by 30-June, 50% by 5-July, and 75% by 10-July (Figure 2). During this period, run timings ranged plus or minus three days with the earliest having 50% return by 2-July and the latest by about 8-July (based on combined catch and escapement). However, the curves are most pertinent to the enumeration project at Igiugig where the escapement was estimated because catch was usually less than 50% of the run (2000-2010 average=32%). Sockeye usually take 2-4 days to travel from the fishing district upstream to the enumeration project at Igiugig (T. Baker, pers. comm., Research Biologist, ADF&G).

2.3.4 Distribution

When current velocities in the thalweg are high, sockeye salmon are extremely bank oriented while migrating upriver due to the energetic gain in swimming against slower waters near the bank (Woody 2007, Anderson 2000). Taking advantage of this life history trait, W. F. Thompson developed the tower counting system for Bristol Bay in 1953 (Thompson 1962). When tower counts were compared to weir counts (assumed to be a complete census) on the Egegik River, relative error was -7.4% (Rietze 1957, Spangler and Rietze 1958). Therefore, we can assume that most sockeye were susceptible to the counting towers and not swimming in the thalweg; else, the observed relative error would have been much greater. At Igiugig, Anderson (2000) found nearly all sockeye passed 3.0-9.1 m from the left bank (facing upstream) and 3.7-9.1 m from the right bank. Igiugig was chosen for the enumeration project because current velocities in the thalweg likely preclude any crossing over (i.e., swimming across or through the middle of the river). We anticipate that adult sockeye will not encounter the hydrokinetic device, but they will likely encounter any mooring and electrical cables running to shore. Illustrations of the channel cross-section and profile of a generic hydrokinetic device relative to the distribution of adult salmon are presented in a separate document (TBD).

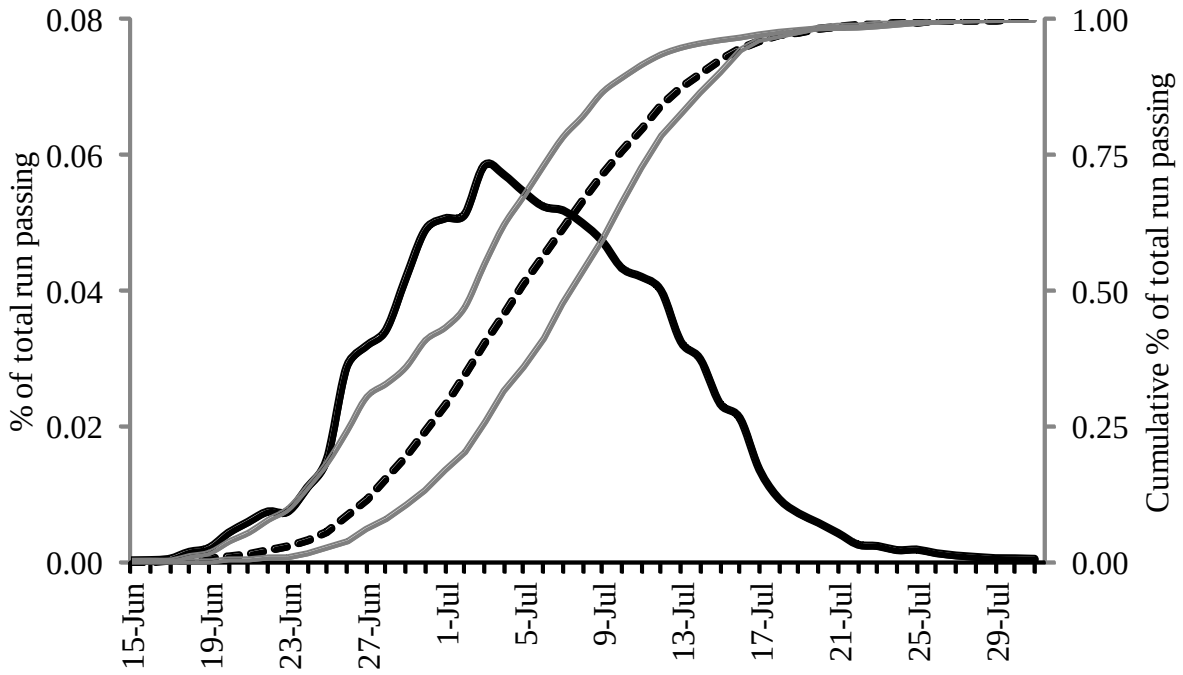


Figure 2. Run timing curves for Kvichak River sockeye salmon. The average run timing from 2000 to 2010 are indicated by thick black lines (daily=solid line and cumulative=dashed line). The earliest and latest cumulative curves during this time period are indicated by gray lines.

2.3.5 Abundance

2.3.5.1 Estimation methods

Relative to most sockeye stocks, the river-specific catch and escapement estimates from Bristol Bay are some of the most accurate and precise in salmon biology today. There is some uncertainty surrounding catch, but precision is not estimated or reported and it is believed to be modest. Uncertainty in catch stems from three sources: (1) how catch is estimated at the time of delivery to the processors, (2) how catch is assigned to natal stream systems, and (3) age composition estimation (T. Baker, pers. comm., Regional Research Biologist, ADF&G).

Fish are transported with tender vessels from the fishing districts to onshore and floating processing plants located throughout the Bay. Fish are offloaded from tenders into brailer bags and weighed. Throughout each day, fish are sampled for individual weight, which is divided into the total weight from the brailer bags to estimate the number of individuals. Of course, there is some variation around average individual weights, but these weights are routinely updated throughout the season and this variability is considered negligible.

Catch from fishing districts with only one stream system are assigned to that stream (i.e., Togiak, Ugashik, and Egegik). For districts with more than one river system, catch has historically been apportioned post-season based on relative escapements by age (Bernard 1983). For instance, the

catch of sockeye Age-2.2 in the Kvichak-Naknek District is apportioned between the Kvichak and Naknek systems based on the relative proportion of Age-2.2 fish that occurred in each escapement.

It has always been assumed that once sockeye enter the Bay, interception of fish bound for natal districts and streams is for the most part small; assumptions necessitate uncertainty. However, these assumptions have not been needed in recent years due to genetic stock identification (GSI) from catch samples. Dann et al. (2009) found the percent of the Kvichak run harvested in the Ugashik and Egegik districts was 4.7% in 2006, 4.9% in 2007, and 13.2% in 2008. An additional genetics study is underway that will estimate the stock mixtures for the historical database based on scale samples taken in earlier years (Tyler Dann, pers. comm., ADF&G). Better estimates of river-specific harvest may change historical and future catch assignments enough to alter previously held conceptions of abundance trends and spawner-recruit relationships for some systems (Baker et al. 2009), but we doubt these changes will be substantial.

The history and accuracy associated with the tower counting system in Bristol Bay is described by Woody (2007), while methods for efficiently estimating sampling error (precision) can be found in Reynolds et al. (2007). Towers are constructed on clear streams such as the Kvichak at sites amenable to sampling, which is circumscribed by a set of guidelines (Woody 2007). As previously mentioned, tower counts were very close to weir counts on the Egegik River (relative error was -7.4%; Rietze 1957, Spangler and Rietze 1958). The sources of error include: (1) observer variability, (2) aspects of migration, (3) weather conditions, and (4) sampling error due to subsampling (Woody 2007).

Observer variability is negligible; even when experienced observers were compared to the inexperienced, percent errors ranged from -1.8% to +1.3% (Anderson 2000). Species confusion is possible as several salmonids share natal streams, but Bay systems are dominated by sockeye and some species are easily distinguished (e.g., Chinook salmon) and/or have different run timings (e.g., coho salmon). High density passage of fish may bias observer counts, but using a replicated systematic sampling design with 20 min counting intervals will reduce this bias (Siebel 1967, Reynolds et al. 2007). Bias from weather conditions are difficult to quantify, but Woody (2007) recommends careful site selection to reduce glare and wind, polarized glasses, riffle dampeners to reduce surface turbulence, and lighter colored substrates to provide contrast as salmon pass over. Sampling error has been carefully examined and established protocols are statistically well vetted (Reynolds et al. 2007). No metrics of uncertainty are currently reported by ADF&G, but a 95% confidence interval was found to be <5% of the estimates for recent years in all systems (unpublished analysis of escapement counts using methods as per Reynolds et al. [2007]).

2.3.5.2 Trends in abundance

Sockeye salmon abundance in Bristol Bay has fluctuated significantly during the past century in spite of attempts to stabilize returns through management of spawning populations (escapement). The run reached a 100-year low in the early 1970s, and then rapidly rebounded to record high levels in response to the 1976/77 climate regime shift (Rogers and Poe 1984, Adkison et al. 1996, Peterman et al. 2003). The Bay-wide run followed a cycle of high returns for one and two

years followed by “off-cycle” years of lower returns, driven by the dynamics of the Kvichak River system (Figure 3, Table 2).

However, beginning in 1996 and continuing for about a decade, relatively few sockeye salmon returned to the Kvichak River, which had previously produced terminal runs up to 23-42 million salmon per year during periodic peak cycle-years (these occur about every five years) in the 1960s and early 1970s. On average, the total annual abundance (catch and escapement) of Kvichak sockeye salmon declined 74% from 1978-1995 (14.8 million salmon) to 1996-2005 (3.8 million salmon). The sharp decline in returns produced an even greater decline in harvest (84%) as managers attempted to restrict fishing and allow nearly the entire run to escape to the spawning grounds.

Thus, two historical aspects of Kvichak sockeye salmon are worth noting: (1) the 5-year cyclic pattern in abundance, and (2) the overall decline in abundance beginning in the mid 1990s. Reasons for the cycle have not been definitive, and debate in the Bay continues, but the data suggest it is influenced by an interaction of marine and freshwater processes and largely reinforced by historical fishing patterns and escapement goal policy. Ruggerone and Link (2006) provided evidence that the cyclic abundance of Kvichak sockeye salmon was maintained by depensatory fishing mortality, density-dependent interactions between brood lines, low productivity of the Kvichak watershed, and the relatively stable 5-year life cycle of Kvichak salmon rather than natural depensatory mortality caused by predators or marine derived nutrients. Whatever the cause, the cycle began to break down during the mid 1990s and the Kvichak has failed to dominate the run since. Speculation about factors causing the Kvichak collapse grew as the series of low runs continued from 1996 through 2005.

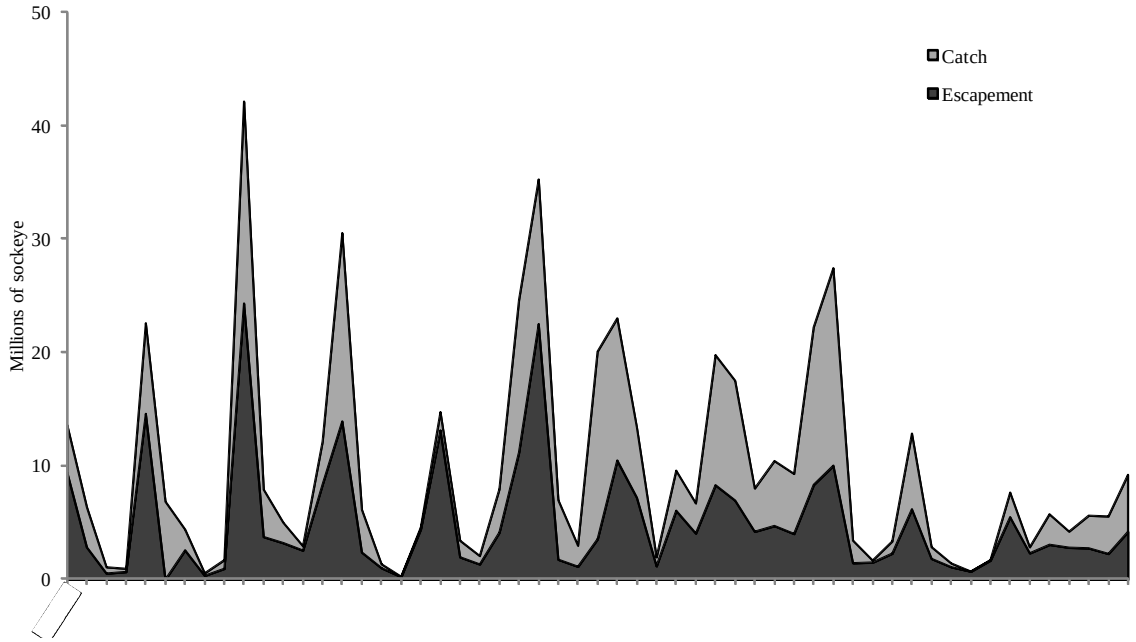


Figure 3. Catch and escapement trends for Kvichak sockeye salmon.

Table 2. Historical catch and escapement of Kvichak sockeye salmon.

Year	Catch	Escapement	Total
1956	4,168,343	9,443,318	13,611,661
1957	3,540,189	2,842,810	6,382,999
1958	549,396	534,785	1,084,181
1959	281,930	673,811	955,741
1960	7,976,500	14,602,360	22,578,860
1961	6,863,814	-	6,863,814
1962	1,833,401	2,580,884	4,414,285
1963	223,459	338,760	562,219
1964	763,486	957,120	1,720,606
1965	17,785,664	24,325,926	42,111,590
1966	4,168,575	3,755,185	7,923,760
1967	1,800,652	3,216,208	5,016,860
1968	387,565	2,557,440	2,945,005
1969	3,760,565	8,394,204	12,154,769
1970	16,581,224	13,935,306	30,516,530
1971	3,764,861	2,387,392	6,152,253
1972	342,150	1,009,962	1,352,112
1973	21,791	226,554	248,345
1974	148,595	4,433,844	4,582,439
1975	1,605,407	13,140,450	14,745,857
1976	1,458,180	1,965,282	3,423,462
1977	739,464	1,341,144	2,080,608
1978	3,815,636	4,149,288	7,964,924
1979	13,418,829	11,218,434	24,637,263
1980	12,743,074	22,505,268	35,248,342
1981	5,234,733	1,754,358	6,989,091
1982	1,858,475	1,134,840	2,993,315
1983	16,534,901	3,569,982	20,104,883
1984	12,523,803	10,490,670	23,014,473
1985	6,183,103	7,211,046	13,394,149
1986	787,303	1,179,322	1,966,625
1987	3,526,824	6,065,880	9,592,704
1988	2,654,364	4,065,216	6,719,580
1989	11,456,509	8,317,500	19,774,009
1990	10,551,217	6,970,020	17,521,237
1991	3,808,873	4,222,788	8,031,661
1992	5,718,947	4,725,864	10,444,811
1993	5,287,523	4,025,166	9,312,689
1994	13,893,613	8,355,936	22,249,549
1995	17,391,906	10,038,720	27,430,626
1996	1,983,269	1,450,578	3,433,847
1997	179,480	1,503,732	1,683,212
1998	1,072,760	2,296,074	3,368,834
1999	6,663,209	6,196,914	12,860,123
2000	1,033,814	1,827,780	2,861,594
2001	330,538	1,095,348	1,425,886
2002	-	703,884	703,884
2003	34,244	1,686,804	1,721,048
2004	2,163,318	5,500,134	7,663,452
2005	532,450	2,320,332	2,852,782
2006	2,687,895	3,068,226	5,756,121
2007	1,420,384	2,810,208	4,230,592
2008	2,873,889	2,757,912	5,631,801
2009	3,297,344	2,266,140	5,563,484
2010	5,018,048	4,207,410	9,225,458
10 yr avg.	3,967,974	3,552,998	7,322,573

Most recently (2006-2010), the Kvichak run has averaged a 6.1 million return (range=4-9, Table 2). The age-structure for the Kvichak varies among four age classes Age-1.2, Age-1.3, Age-1.4, and Age-2.3 (European notation—1st number=freshwater age, 2nd=ocean age, Table 3). However, 2-ocean fish usually dominate, and when they do not the run is typically small. On average 60% return 5 years after the year in which they were spawned as Age-2.2s or Age-1.3s (return time is calculated by adding the freshwater and ocean ages plus one year for overwinter incubation of the eggs).

Table 3. Age composition of Kvichak sockeye salmon. Age values represent percentages.

Year	Age 1.2	Age 1.3	Age 2.2	Age 2.3	2-ocean	3-ocean	Total run (millions)
1990	4	7	75	14	79	21	18
1991	51	13	17	19	68	32	8
1992	23	23	41	12	65	35	11
1993	22	25	45	7	67	33	10
1994	7	7	83	2	90	10	23
1995	9	4	75	12	84	16	28
1996	12	35	20	33	32	68	4
1997	47	12	31	9	78	22	2
1998	51	26	18	4	69	31	4
1999	58	9	28	4	87	13	13
2000	12	60	20	8	32	68	3
2001	9	84	1	5	10	90	1
2002	45	15	37	2	83	17	1
2003	64	17	15	4	79	21	2
2004	23	3	73	1	96	4	8
2005	18	41	32	9	50	50	3
2006	45	31	17	7	62	38	6
2007	63	18	3	16	66	34	4
2008	73	25	1	0	74	26	6
2009	18	40	40	2	57	43	6

2.4 JUVENILE SOCKEYE

As Pacific salmon complete the fresh water stage of their life cycle, they undergo physiological changes in order to make the transition to salt water. This parr-smolt transformation also includes changes in morphology and behavior that favors increased survival at sea (Groot and Margolis 1991). Starting in the early 1950s fisheries scientists from the University of Washington and the U.S. Fish and Wildlife Service started collecting biological data from the out-migrating sockeye salmon smolts in the Bristol Bay region (LGL unpublished data). Due to the subsistence and economic value of sockeye salmon in Bristol Bay, the majority of these studies were concentrated on this one species.

Starting in 1957 a smolt program was implemented on the Kvichak River near the village of Igiugig; in 1961 ADF&G became the lead organization and have annually collected smolt data

through 2011 (Crawford 2001). Biological data collected from these early studies includes age, length and weight; in addition to this information smolt run timing data were collected and relative abundance was estimated. Fyke nets were used from 1956 – 1970 to capture smolts; thus, the relative abundance estimate was based on catch per unit effort. In 1971, hydroacoustics were first tested on the Kvichak River to determine if an absolute smolt abundance could be estimated. The results were rigorous enough that this method was utilized by the Department through 2000 (Crawford and West 2001). Due to problems with aging sonar equipment and budget cuts, the ADF&G sonar portion of smolt monitoring on the Kvichak River was discontinued in 2001, however biological data continued to be gathered through 2011(Crawford and Fair 2003). In 2007, the Bristol Bay Science and Research Institute (BBSRI) designed and built a new sonar that could be used to estimate smolt outmigration in the rivers of Bristol Bay; this was first tested on the Kvichak River in 2008 and has since operated annually to date (Wade et al. 2010a, b, 2011).

Sockeye salmon smolt behavior on the Kvichak River has been characterized over the years based on fyke net catches and sonar data. Across years, smolts tend to follow the same general behavior patterns in regards to run timing and distribution in the water column. These behaviors are in part driven by the evolutionary pressure for survival (Groot and Margolis 1991).

2.4.1 Timing

Environmental conditions are the primary factors that trigger the parr-smolt transformation. Photoperiod appears to drive this transformation, but water temperature also influences the timing of the annual outmigration (Groot and Margolis 1991, Quinn 2005). On the Kvichak River, out-migration generally coincides with the melting of ice on Lake Iliamna (mid-May) and is the timing for smolt sampling projects (Crawford 2001). The length of the out-migration for sockeye salmon is somewhat compressed relative to other species of Pacific salmon (Quinn 2005). On the Kvichak River, the entire duration of the run is 2 to 3 weeks with the majority of fish out-migrating in the last week of May. According to sonar data collected by BBSRI, from 2008 – 2010 greater than 85 % of total smolts were detected in a period of 9 days, with 4 day peaks during this time accounting for > 50% (Wade et al. 2010a, b, 2011; Figures 4 and 5).

2.4.2 Distribution

Past studies that have characterized smolt behavior on the Kvichak River have indicated that the majority of the out-migrating smolts will utilize the upper portion of the water column. For example, from video data from 2000 and acoustic data from 2000 and 2001, Maxwell et al. (2009) found that all smolts traveled in the top 1.0 m of water, and the majority of smolts were in the top 0.3 m. The BBSRI study (2008 – 2010) characterized vertical distribution in 0.5 m bins down to 2.5 m in depth, and then divided these data into 2 categories (dark, daylight) to check for diel differences in distribution. On the Kvichak River, the smolt vertical distribution was extremely consistent across years for both periods of daylight and darkness (Figure 6). During the periods of darkness > 90.0% of smolts were detected in the upper 1.0 m and on average > 80.0 % were found in the upper 0.5 m. Daylight distribution tended to be a little deeper, but in all cases > 81.0% were found in the 0.0 to 1.5 m strata. By utilizing the upper portion of the water column, smolts travel in the higher velocity water and therefore reduce the amount of energy expended to reach the sea.

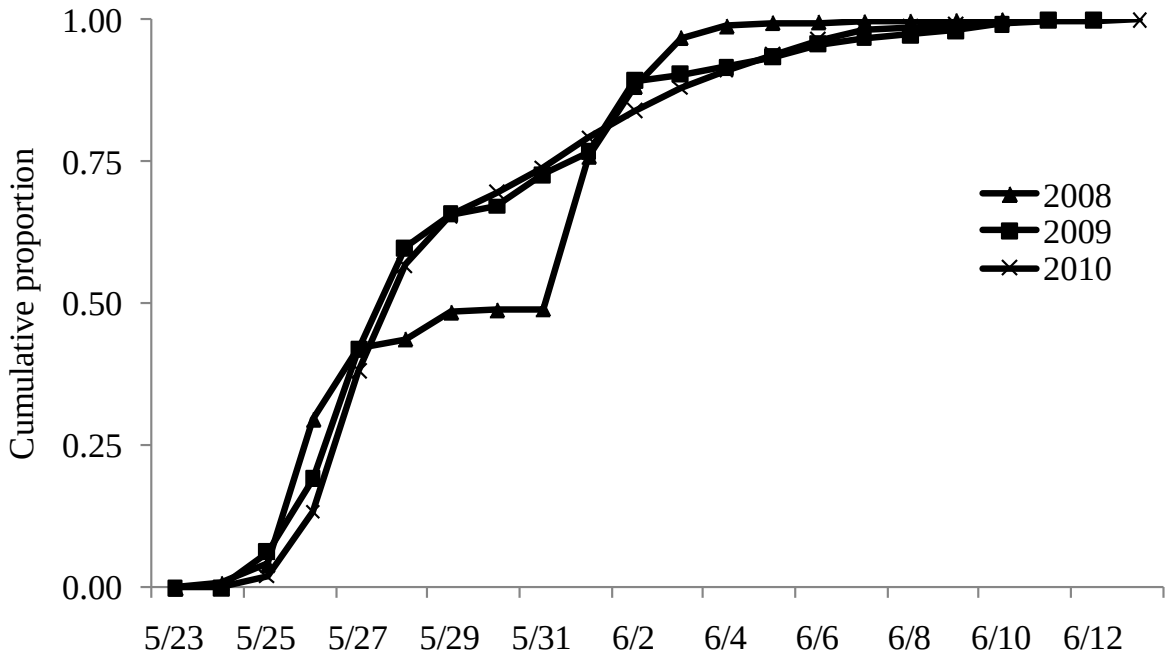


Figure 4. Run timing curves of sockeye smolt outmigration.

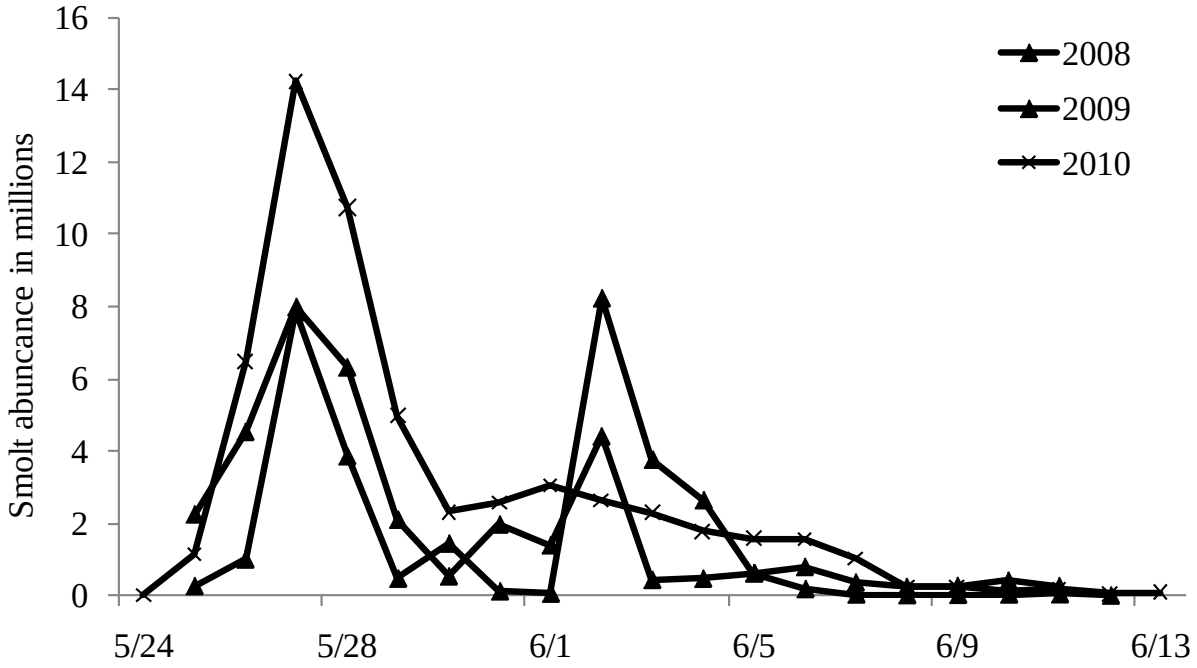


Figure 5. Estimated daily sockeye smolt abundance on the Kvichak River, 2008 – 2010.

Smolt cross-river distribution follows the same general pattern across years. In areas where there is a more pronounced thalweg, the majority of the smolts utilized these deeper, higher velocity areas. Sonar Site 1 on the Kvichak River is a good example of this distribution and, in all cases, the majority of the smolts were detected in the deeper, faster water (Figure 7). In 2008 and 2009, the Kvichak Site 1 sonar has detected > 72% of all smolts located 49 – 69 m off the west bank. In 2010, the cross-river distribution at Site 1 was a little more evenly distributed across a greater portion of the river; however the deeper portion of the river remained the area where smolts were most abundant. We anticipate that juvenile sockeye will encounter the hydrokinetic device and any mooring and electrical cables running to shore. Illustrations of the channel cross-section and profile of a generic hydrokinetic device relative to the distribution of juvenile salmon are presented in a separate document (TBD).

2.4.3 Abundance

Yearly smolt abundance on the Kvichak River has been estimated annually from 1957 to 2001 by ADF&G. Starting in 2008, BBSRI reinstated the program and have continued through 2011. During the history of this program the methods for estimating abundance have gone through three fundamentally different changes (LGL unpublished data) so comparison of absolute numbers across years is not valid. However, due to the difficultly in capturing smolts by nets, it is believed that estimates derived by hydroacoustics more accurately reflect the actual number of fish. During the period of time when the ADF&G sonar was thought to be operating correctly (1972 - 1992), annual estimates varied from 15 to 342 million smolts. The BBSRI estimates for Site 1 on the Kvichak River have ranged from 30 – 57 million smolts (Figure 5). Given the short duration of the smolt outmigration, it is feasible that greater than 20 million smolts could move down the river in a 24 hour period.

2.5 OTHER SALMON

The Kvichak River is home to all five species of Pacific salmon including sockeye, Chinook, coho, chum, and pink (Table 4), and they are fished commercially and for subsistence (Table 5). Although extensive research has been conducted on sockeye in this region, very little effort has been dedicated to the study of the other four species of salmon. ADF&G conducts annual spawning ground surveys in the Naknek/Kvichak drainage, but the majority of the effort is focused on the Naknek River and its tributaries (Salomone et al. 2009) which are downstream of Igiugig and the proposed hydrokinetic project. According to the ADF&G Anadromous Waters Catalog, several streams above the village of Igiugig support spawning populations of sockeye, Chinook, and coho, whereas pink and chum salmon are rarely found (Table 4). All Pacific salmon are anadromous and share similar life histories with respect to spawning migration. However, in order to reduce competition among species, they will utilize specific run timing and spawning habitats (Groot and Margolis 1991, Table 3 in Hauser 2007). In general, pink and chum spawn in the lower reaches of rivers while sockeye, Chinook and coho will travel further up the basin to preferred spawning and rearing habitat.

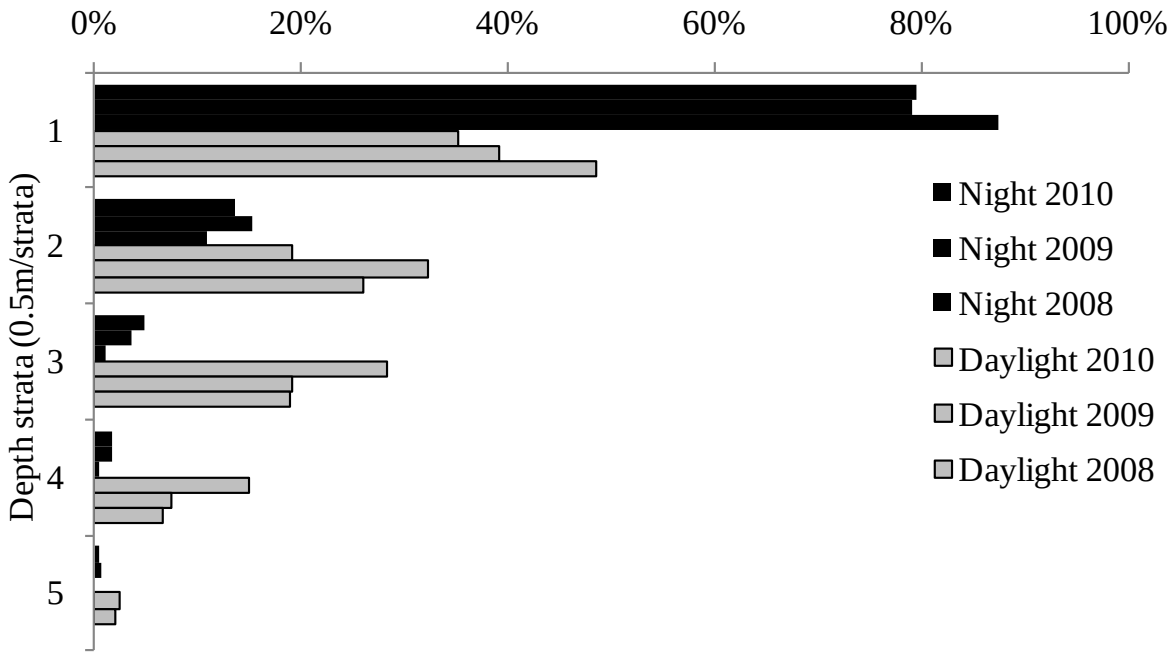


Figure 6. Vertical distribution of out migrating sockeye smolts on the Kvichak River, 2008 – 2010.

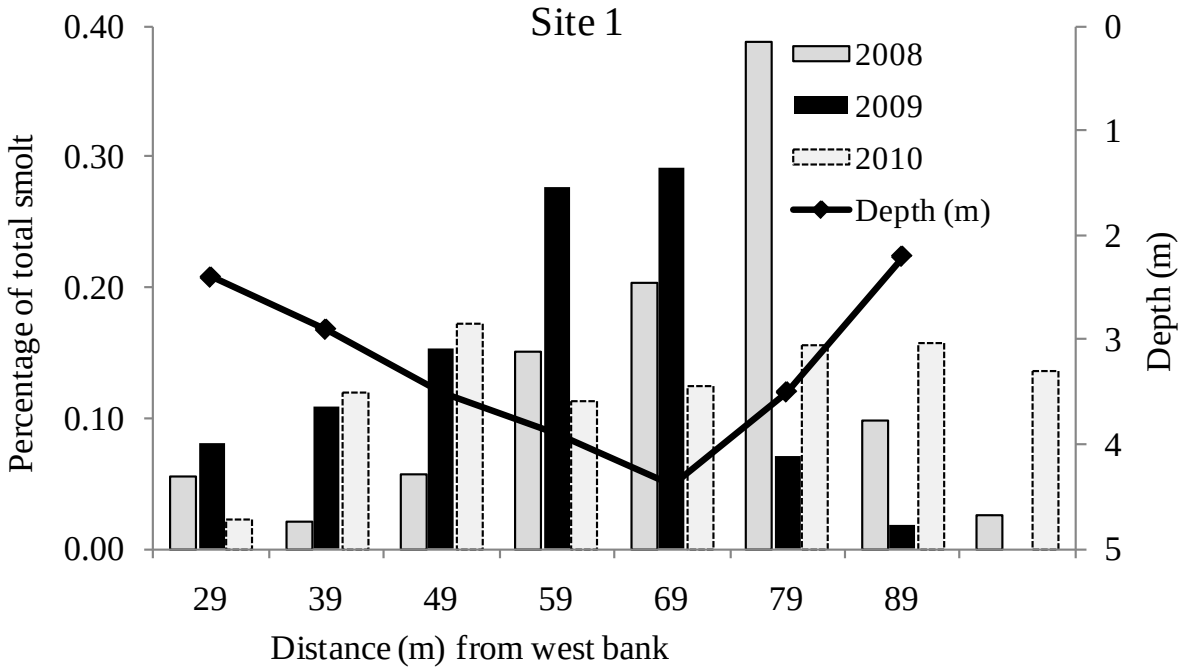


Figure 7. Cross-river distribution of sockeye smolt on the Kvichak River, 2008 – 2010.

Table 4. Distribution of salmon in tributaries of the Kvichak River, by life stage.

	Species/Lifestage[a]				
Location	Sockeye	Chinook	Coho	Pink	Chum
Kaskanak Creek	p	s	s	s	s
Ole Creek	s	p	p		p
Pecks Creek	s	p	p		s
Belinda Creek	s	s			
Dennis Creek	s				
Gibraltar Creek	s				s
Kakhonak River	s				
Copper River	s	s			
Tommy Creek	s				
Iliamna River	s	p	p	p	p
Pile River	s				
Knutson Creek	s				
Canyon Creek	s				
Chekok Creek	s		p		
Chekok Bay Creek	s		p		
Stonehouse Creek	s				
Eagle Bay Creek East	s				
Eagle Bay Creek West	s				
Roadhouse Creek	s		s		
Newhalen River	s	s	p		
Pete Andrews Creek	s				
Upper Talarik Creek	s, r	s	s, r	p	s
Lower Talarik Creek	s	p	s		
324-10-10150-2155	s		p		

[a] p - present, m - migration, r - rearing, s - spawning. Alaska Department of Fish and Game (2011). Anadromous Waters Catalog Overview.

Table 5. Historical salmon harvest in the Kvichak River region.

Naknek/Kvichak Harvest - 20 Year Average[a]	Sockeye	Chinook	Coho	Chum	Pink
Commercial (1990 - 2010)[b]	8,238,895	2,816	4,436	255,487	73,661
Subsistence (1989 - 2009)	77,653	1,323	1,218	844	957

[a] Morstad et al. 2010, Salomone et al. 2011
[b] Commercial fishing is limited to Kvichak Bay (i.e., no commercial fishing occurs in the Kvichak River).

Chinook, coho and chum salmon are known to spawn above Igiugig, but there is very little data available that characterizes their juvenile life stages (ADF&G 2011). ADF&G records incidental non-sockeye catch that occurs during the sockeye smolt project on the Kvichak River, but abundance and run timing are not estimated using these data (Crawford 2001). Regardless, the outmigrating smolts from these species could encounter a RISEC device when we assume their behavior during active outmigration would be similar to that of the sockeye smolts (Quinn 2005, Groot and Margolis 1991). The age at which Chinook and coho will smolt varies from system to system, but ranges from 0 to 2 years for Chinook and 0 to 4 years for coho (Morrow 1980, Quinn 2005, Groot and Margolis 1991). Chum salmon all outmigrate after emergence from the gravel as age 0 smolts (Groot and Margolis 1991). Generally speaking, age 1 and older Chinook and coho smolts are larger than the respective aged sockeye smolts or age 0 chum, so they may be better able to avoid a RISEC device.

3.0 POTENTIAL EFFECTS ON FISH

Fish that enter the zone of influence (ZOI) of a device are deemed to have encountered the device. Fish can enter the ZOI from any direction, but most will likely come from upstream or downstream. In either case, there is potential for the fish to be influenced physically through contact, or in its behavior through sensory perception. The hydraulic and cover conditions created by a device may influence these interactions. We speculate below on the types of interactions and outcomes resulting from fish encountering a device at the proposed location.

3.1 HYDRAULICS AND STRUCTURES

Installing a device in the river will modify water conditions in the immediate area. The structure itself may provide a form of cover for fish, both visually and hydraulically. Further, if scour of the river bed occurs due to the modified hydraulics from the device or its anchors, preferred fish habitat may be created or destroyed. Fish tend to reside or migrate in close proximity to in-water or overhead structures as a form of protection from visual predators and energetically intensive conditions (e.g., high water velocity). Therefore, the device may create conditions that are preferred by fish, albeit in a relatively small area. Creation of fish friendly habitat may result in fish temporarily using the structure for cover or feeding. Given that this immediate area of the Kvichak River is essentially devoid of fish cover, modification of conditions by the device could be beneficial for larger fish (predators), but detrimental for smaller fish (prey). On the contrary, fish can also be wary of unusual structures, especially moving ones, and may attempt to avoid it. Avoidance may be in the form of swimming around a structure, reversing direction, or halting directional movement. The degree to which these conditions develop will determine whether the effects are proportionally positive, negative or neutral to the species and life stage of the fish population involved.

3.2 PHYSICAL CONTACT WITH A DEVICE

Installing a device in the river will create a new and changing physical surface with which fish could come in contact. Adult and juvenile fish are constantly navigating around and through in-water structures, and use visual and pressure senses to suitably position themselves. In water of relatively high energy (velocity or turbulence), fish may not have adequate time to react and avoid contact. Juvenile fish in particular may not have adequate swimming power. Further,

where an in-water structure is moving or has edges, the probability of a collision is higher. Therefore, it is possible that a fish could come in contact with a device and sustain an injury. Injury could be in the form of temporary disorientation, bruising, or laceration. The frequency and extent of the injury(s) will determine whether the effects are negative or neutral to the species and life-stage of the fish population involved.

Given the anticipated environmental conditions and the inherent ability of fish to navigate around structures, adult fish should be able to avoid the device by changing their path or position with no effect to their overall health and fitness. The fate of juvenile fish is less certain, but will be determined as part of impact monitoring.

3.3 EXISTING STUDIES

Due to the fact that development of hydrokinetic energy is relatively new in the U.S. there is a limited amount of research that characterizes fish/device interactions. Some of the effects traditional hydro-power may have on fish have been applied to hydrokinetic devices, but given the vast difference between the two methods it is difficult to draw direct comparisons (Normandeau 2009). There has been some effort on the East Coast to study hydrokinetic devices in situ but very little has been done in Alaska or with fish species that will be encountered in Alaska (Viehmen et al. 2011, Zydlewski et al. 2010, New York State Energy Research and Development Authority 2011). The School of Fisheries and Ocean Sciences at UAF has begun to study the potential impacts of hydrokinetic devices on the Tanana River near Nenana, AK (Seitz et al. 2011, Bradley and Seitz 2011). To date, these studies have primarily dealt with the development of baseline data and have not examined fish/device interactions. Although there are no studies that can directly link fish/device interactions in Alaska, much can be learned from these earlier studies regarding fish passage and methodologies for monitoring hydrokinetic devices (Table 6).

4.0 POTENTIAL EFFECTS ON WILDLIFE

Although much of the monitoring will focus on fish/device interactions, there remains the possibility of other wildlife within the ZOI. In the event of a beluga whale or harbor seal sighting, a Marine Mammal sighting form must be completed (Appendix B). If any of the terrestrial or aquatic mammals or Bald Eagles are spotted on or interacting with the device it must be recorded in the incidental sightings form (Appendix B). At no time is approaching or harassing birds and wildlife permitted.

Table 6. Outline of studies that examine fish/device interactions.

Title	Report Prepared For/ Prepared By	Overview	Study Type/Turbine Design
Characterization of the juvenile fish community in the middle Tanana River near Nenana, AK.[1]	Bradley and Seitz. 2011. School of Fisheries and Ocean Science, University of Alaska Fairbanks	Study to characterize the spatial and temporal distribution of of down-migrating juvenile fishes on the Tanana River at a proposed hydrokinetic site.	In situ
EPRI-sponsored computer modeling and laboratory evaluation of the effects of leading edge geometry and blade speed on fish strike.[2]	EPRI/Alden Research Laboratory, Inc.	Determine optimum leading edge geometry for deflecting fish using computer modeling and estimate survival rates for various fish length to blade thickness over a range of strikes	Modeling
Assessment of the environmental effects of hydrokinetic turbines on fish: desktop and laboratory flume studies.[3]	Electric Power Research Institute (EPRI)/Alden Research Laboratory, Inc.	Determine injury, survival rates and behavioral effects for fish passing through hydrokinetic turbines. Flume studies were conducted on three turbine designs on several species and fish class sizes.	Modeling and Flume/ Darrieus, Lucid spherical, and Welka UPG axial flow
Fish passage through turbines: Application of conventional hydropower data to hydrokinetic technologies.[4]	Electric Power Research Institute (EPRI)/Alden Research Laboratory, Inc.	Compares effects of shear, turbulence, pressure, cavitation, and mechanical strikes between conventional hydropower and hydrokinetics	Modeling
An estimation of survival and injury of fish passed through the HydroGreen energy hydrokinetic system, and a characterization of fish entrainment potential at the Mississippi lock and dam No. 2 hydroelectric project.[5]	Hydro Green Energy (HGE)/Normandeau Associates, Inc.	The survival and injury of fish passed through the HGE hydrokinetic turbine was directly assessed using the HI-Z Turb'N tag (i.e., HI-Z tag) direct recapture technique.	In situ/horizontal axis
Underwater noise measurements of a proposed tidal generator site Cobscook Bay using a drifting noise measurement buoy, including ambient noise and estimates of tidal generator noise.[6]	Ocean Renewable Power Company (ORPC)/Scientific Solutions, Inc.	Estimate ambient noise at proposed hydrokinetic site and measure the noise levels of the ORPC Beta unit and extrapolate the results to the commercial unit	Modeling & In situ/Darrieus
An initial assessment of fish presence and vertical distribution at two sites (control and proposed tidal power site) in Cobscook Bay.[7]	Ocean Renewable Power Company (ORPC)/University of Maine, School of Marine Sciences and Maine Maritime Academy, Corning School of Ocean Studies	Pre-deployment study using hydroacoustics and net sampling to determine distribution of fish in proposed study and control sites.	In situ/Darrieus
Field evaluation of fish interactions with a commercial-scale marine hydrokinetic device.[8]	Ocean Renewable Power Company (ORPC)/University of Maine, School of Marine Sciences	Observe fish interactions around hydrokinetic device using DIDDON sonars. Characterize near turbine fish behavior with respect to fish size, position in water column, diurnal patterns, and current speed.	In situ/Darrieus
Roosevelt Island tidal energy (RITE) environmental assessment project.[9]	New York State Energy Research and Development Authority/Verdant Power New York, LLC	Pre-deployment fish assessment, development of monitoring plan and monitoring data collected with video and hydroacoustics	In situ/horizontal axis

[1] Bradley and Seitz 2011
[2] Alden 2009
[3] EPRI 2011a
[4] EPRI 2011b
[5] Normandeau 2009
[6] Scientific Solutions Inc. 2011
[7] Viehmen et al. 2011
[8] Zydlewski et al. 2010
[9] New York State Energy Research and Development Authority 2011

5.0 ADAPTIVE MANAGEMENT

The behavior of fish relative to the device will be monitored and documented. This may include data or observations that indicate the device may be causing delay in passage, bodily injury or mortality to fish. Due to these observations, the operation of the device may need to be modified or terminated to prevent or minimize negative effects on aquatic resources. Observational data will be reviewed in-situ by the lead field biologist to ascertain if any negative impacts to fish appear to be occurring. Evidence of migration delay, modified travel paths, stress, injury, or mortality will be brought immediately to the attention of the Project Engineer. Any resource critical situations will be relayed to Igiugig council staff, AEA, and regulatory agencies for discussion.

We will implement a process of adaptive management as guided by five primary steps:

1. Observation – field crew reports a potentially undesirable effect of a device to the Senior Biologist by providing relevant documentation (who/what/where/when/why/how):
    a. potential passage delay – at least 50% of the observable population hold or turn around
    b. potential bodily injury – at least 10% of the observable population contact the device
    c. potential mortality – observation of any moribund fish after passing the device
2. Reporting – Senior Biologist evaluates the impact and severity of the effect, and reports the situation with a recommendation for action to the Project Engineer. If needed, the Senior Biologist has the authority to temporarily shut down operations;
3. Consideration – Project Engineer assesses the situation and decides to:
    a. concur with the Senior Biologists' recommended action
    b. request additional information from the Senior Biologist
    c. recommend an alternative action
    d. Action options include:
        i. no change to operation and continue monitoring
        ii. modify operation and continue monitoring
        iii. temporarily terminate operations (shut down), modify the operation, and the resume operations with continued monitoring
        iv. terminate the operation until further notice (shut down or removal)
4. Action – Project Engineer and Senior Biologist implement the action(s). If operations are continued, then close observational monitoring is conducted to look for recurrence of the situation.
5. Consultation – Project Engineer contacts regulatory agency(s) to report, discuss, and decide actions of operation.

A similar process will be implemented for the device operator and the general public (separate document, TBD). Routine visits to the device for power operations will include an inspection of the structure and vicinity for fish/wildlife interaction with the device. The operator/observer will look for and document any observations of fish in proximity to the device that are displaying unusual behavior or contacting the device. We anticipate that the general public will inform staff of the Igiugig Village Council if they perceive that a device is causing a negative effect on fish or

wildlife. Council will forward any observations or concerns to the Project Engineer for consideration and action.

All available information will be considered in defining a negative effect and developing a mitigative response. There may be opportunities to mitigate for the impacts. First, it may be practical to not operate the device during specific and critical fish periods, and thereby eliminate the impact. For example, shutting down the turbine for 10 days in late May / early June would avoid approximately 90% of the juvenile sockeye run. Second, it may also be practical to move the device or its accessories to an alternate location to eliminate the impact. This could be as minimal as several feet to make a difference. For example, if the device appeared to be operating in the migration corridor of highest fish use, the device could be moved toward or away from shore to avoid the area of concentration. Lastly, observations may provide insight to structural design, structural materials, or auxiliary equipment that minimize or eliminate the impact.

6.0 MONITORING METHODS & CRITERIA

6.1 PURPOSE

The primary objective of the monitoring program is to document how migrating fish interact with and pass the RISEC devices. Data collection will characterize fish and their behavior in proximity to the device(s) by observing downstream migrating juveniles, and upstream or downstream migrating adults (Table 6). This information will then be used to evaluate whether there was an effect of biological significance, and if an effect constitutes a negative impact to the population. Wildlife monitoring will be conducted incidental to the data collection program.

6.2 SPECIES AND LOCATION

The primary fauna of interest are any species and life stage of fish, but we anticipate the focus will be on salmon and trout (Table 7) due to their relative abundance and distribution. Secondarily, any species of wildlife will be monitored, but likely candidates include marine and terrestrial mammals. One or more RISEC devices will be located at Site 6 (TerraSond 2011). Observational data will be collected in the waters designated as the ZOI. The ZOI will extend to where fish can sense the device due to its structure or operation, or have an opportunity to encounter the device or its effected area. The ZOI will be qualified through observation and inference.

6.3 TIMING OF MONITORING

We propose to conduct periodic monitoring operations as based on when peak fish abundance for the anticipated species are assumed to occur (Table 7), or at the time when a device is first operated. Targeting the peak abundance periods will provide the greatest opportunity to collect observational data, and monitoring during initial device operations will ensure timely assessments. Further, we propose that each monitoring period last for approximately 7 to 14 days to gain a suitable abundance and diversity of observations. The actual number of days would depend on the frequency and number of biologically useful observations documented

during the period. Obtaining observations for each of the target species will depend on when the RISEC device(s) are deployed. Target monitoring periods include:

- Unspecified: any time a device is first operated;
- 24 May - 4 June: juvenile sockeye and other salmon outmigration;
- 5 June - 18 June: adult rainbow & Dolly Varden;
- 3 July - 16 July: adult salmon (sockeye, Chinook, coho, chum, pink);
- 4 Sep - 17 Sep: adult rainbow & Dolly Varden;

Table 7. Fish species anticipated to be observed in the ZOI of a RISEC device on the Kvichak River, and the potential methods used to monitor those fish.

Common Name[a]	Life Stage	Use of Study Site[b]	Timing	Encounter Potential	Contact Surface	Monitoring Methods[c]
rainbow trout	Adult	Migrant/Seasonal	Spring/Fall	likely	device/mooring	v, s, t, es, f, n
	Juvenile	Migrant/Seasonal	Spring	likely	device/mooring	v, s, n
sockeye salmon	Adult	Migrant	Spring/Summer	likely	device/mooring	v, s, t, es, f, n
	Juvenile	Migrant	Spring	likely	device/mooring	v, s, n
coho salmon	Adult	Migrant	Summer/Fall	possible	device/mooring	v, s, t, es, f, n
	Juvenile	Migrant	Spring	possible	device/mooring	v, s, n
Chinook salmon	Adult	Migrant	Summer	possible	device/mooring	v, s, t, es, f, n
	Juvenile	Migrant	Spring	possible	device/mooring	v, s, n
pink salmon	Adult	Migrant	Summer	possible	device/mooring	v, s, t, es, f, n
	Juvenile	Migrant	Spring	possible	device/mooring	v, s, n
chum salmon	Adult	Migrant	Summer	possible	device/mooring	v, s, t, es, f, n
	Juvenile	Migrant	Spring	possible	device/mooring	v, s, n
Dolly Varden	Adult	Migrant/Seasonal	Spring/Fall	possible	device/mooring	v, s, t, es, f, n
	Juvenile	Migrant/Seasonal	unknown	possible	device/mooring	v, s, n
humpback whitefish	Adult	Migrant	Fall	possible	device/mooring	v, s, t, es, f, n
	Juvenile	Migrant	unknown	possible	device/mooring	v, s, n
threespine stickleback	Adult	Resident	year-round	possible	mooring	v, s, n
	Juvenile	Resident	unknown	possible	mooring	v, s, n
ninespine stickleback	Adult	Resident	year-round	possible	mooring	v, s, n
	Juvenile	Resident	unknown	possible	mooring	v, s, n

[a]Alt 1994 a, b
Fall et al. 2010
Gryska 2007
Groot and Margolis 1991
Hauser 2007
Hubartt 1994
Krieg et al. 2003
Mansfield 2004
Mecklenburg et al. 2002
Minard et al. 1992
Morrow 1980
Quinn 2005
Salomone et al. 2009
Woody and Young 2007

[b] Migrant - utilize study site seasonally as a migratory corridor
Seasonal - May reside in study site
non-typical - rarely encontered in study site
Resident - Majority of life cycle could occur in study site

[c] s - snorkel, v - video, n - net, f - fishing, t - tower, es - echosounding

Approximate monitoring periods are highlighted in the calendar below. In 2012, it is most probable that operations and monitoring will occur only in September. The 2012 operations can thus be considered pilot in nature – an opportunity to evaluate monitoring procedures and to refine them for 2013.

Calendar Year

S	M	T	W	T	F	S
JANUARY						
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				
FEBRUARY						
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29			
MARCH						
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
APRIL						
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					
MAY						
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		
JUNE						
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
JULY						
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				
AUGUST						
		1	2	3	4	
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	
SEPTEMBER						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						
OCTOBER						
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			
NOVEMBER						
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	
DECEMBER						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

6.4 STUDY QUESTIONS

There are a series of stepwise questions to ascertain that will support an understanding of the relative impact of a device on fish resources.

1) Do fish encounter the device (i.e., observation of entering the ZOI)? If yes, what species and life stage?
2) How do fish respond behaviorally when they encounter the device? Swim towards it (attraction)? Swim away from it (avoidance)? Do not change course or speed?
3) Do fish make contact with the device? If yes, which species and life stage? How do fish respond behaviorally when they contact the device?
4) Is injury, death or additional physical exertion a result of the encounter or contact? If yes, which species and life stage?
5) Is the relative frequency and abundance of an effect of biological significance? If yes, does it constitute an negative impact on the population (i.e., So what? Does it matter?).

6.5 PROCEDURES

The answers to these questions can be obtained through a variety of qualitative and quantitative fish research methods. Visual observation will be the primary tool to describe the environmental conditions and fish events in the vicinity of a RISEC device (Figure 8). All methods will be implemented with consideration of the anticipated fish species and the unique physical characteristics of each device as to ensure adequate monitoring (Tables 7 and 8). Methods that physically catch fish or capture their behavior at a longer distance can be used if additional information is necessary.

1) Underwater Video

   Strategically located underwater cameras connected to a DVR will be deployed to document fish behavior and contact with the device. We will attempt to mount cameras on the device(s) in such a way as to capture fish approach, passage and egress with respect to a device (Figure 8). This may include one field-of-view (FOV) covering several feet in front of the device, one FOV covering a portion of the turbine, and one FOV covering several feet downstream of the device. From these angles, it is anticipated that we would be able to determine or infer answers to the study questions. Continuous recordings will be searched for fish events and evaluated. This method should provide near-field scale observations. Feasibility of this method will be partly determined by mounting locations on the device and the infrastructure to run cables.

2) Snorkel Surveys

   Biologists outfitted in proper dive gear will make repeated swims through the study area to make observations on fish behavior relative to the RISEC devices. We will be specifically looking for holding or avoidance behaviors by individuals or groups of fish in proximity to the device(s). Surveys will be conducted by one snorkeler floating parallel to the device. This method should provide far-field scale observations. Feasibility of this method will be partly determined by water clarity. A safety boat will be used to aid and assist as necessary. Surveys will include three passes per day, or as feasible. Portable underwater cameras may be used to document environmental conditions or observation events.

3) Tower Observation

   Visual observations of fish behavior or contact with the device will be made from an elevated tower. Feasibility of this method will be partly determined by an appropriate location on the river bank relative to a device, and the distance of the device from the bank. This method should provide far-field scale observations. Observations will be made for a 15 minute periods of each hour where visibility allows.

4) Sonar

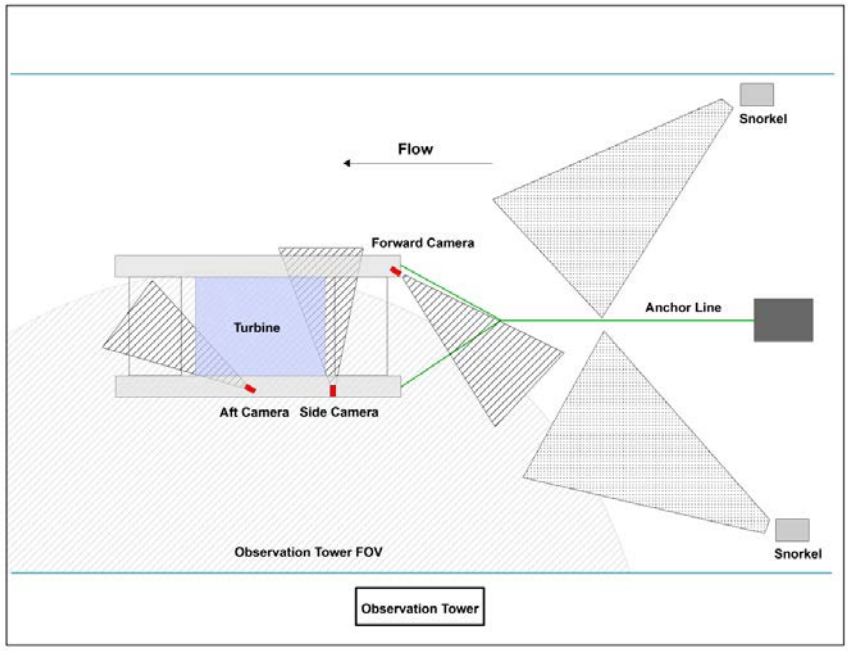
   Split-beam sonar or DIDSON technologies may be used to qualify near and far field fish patterns if other methods are unsuccessful or there is uncertainty about their distribution relative to a device.

5) Angling

   Fishing via hook and line will be used to capture adult fish in proximity to the device. This data will assist in confirming presence/absence, species, and the determination of injuries. This method will only be attempted if the prior methods are unsuccessful or different information is desired.

6) Netting

   A trawl net or seine will be used to capture juvenile fish on the downstream side of the device. This data will assist in confirming presence/absence, species and allowing examination for injuries. This method will only be attempted if the prior methods are unsuccessful or different information is desired.



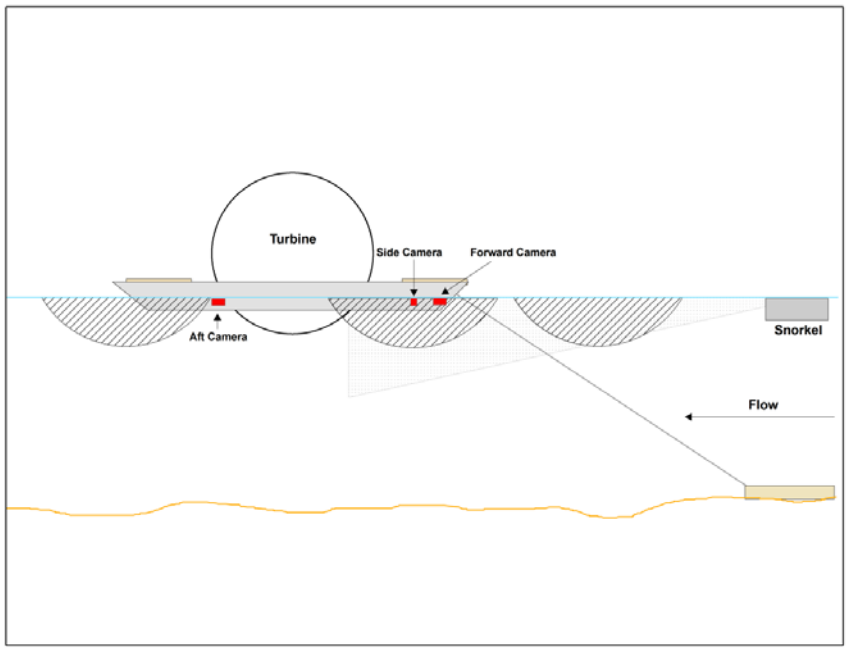


Figure 8. General illustration of observational methods used to monitor the interaction of fish with RISEC devices. These illustrations are hypothetical in nature and do not necessarily represent the actual device type, size or scale.

Table 8. Matrix of hydrokinetic devices and respective monitoring methods for fish.

GENERAL TURBINE DESCRIPTION	Darrieus Turbine (Lift)	Paddlewheel (Drag)	Oscillating Rudders (Drag)	Savonius Turbine (Drag)
Max Footprint (LxWxH)	45' x 45' x 20'	35' x 45' x 20'	35' x 40' x 20'	12' x 25' x 12'
Max Weight	40.000 lbs	25,000 lbs	15,000	10,000
Min Flow Rate	0.5 m/s	1.5 m/s	TBD	1.0 m/s
Max Flow Rates	3.0 m/s	6.0 m/s		2.5 m/s
Min Turbine rpm	5	1.5	TBD	10
Max Turbine rpm	76	20		26
Tip Speed Ratio	1.75 - 2.4	~0.5	0.83	0.6
Device Platform	Floating Platform, Riverbed Structure	Floating Platform	Floating Platform	Floating Device, Riverbed Structure
Water Column Location	Top, Mid	Top	Top	Top, Mid, Bottom
Anchoring	Dead weight Anchor on Riverbed, Screw anchor	Dead weight Anchor on Riverbed, Screw anchor, Shore line/Dead man	Dead weight Anchor on Riverbed, Screw anchor, Shore line/Dead man	Dead weight Anchor on Riverbed, Screw anchor
Example Devices	ORPC ABS/NECI	Whitestone Generic Waterwheel	Pulse Hydro	Hydrovolts
POTENTIAL CONCERNS				
Fish Concern	Strike, Passage time and route	Strike, Passage time and route	Strike, Passage time and route	Strike, Passage time and route
Habitat Concerns	Alter River Hydraulics, Scouring	Alter River Hydraulics	Alter River Hydraulics	Alter River Hydraulics, Scouring
MONITORING				
Biologist Monitoring During Monitoring Periods	Video, Snorkel, Sonar*,Netting* , Tower	Video, Snorkel, Sonar*,Netting* , Tower	Video, Snorkel, Sonar*,Netting* , Tower	Video, Snorkel, Sonar*,Netting* , Tower
Operator Monitoring Ongoing During Operations	Daily Inspection by Boat and Shore	Daily Inspection by Boat and Shore	Daily Inspection by Boat and Shore	Daily Inspection by Boat and Shore
* Monitoring to be implemented only if other methods are proven to be inadequate				

6.6 REPORTING

Trip reports will be prepared for each 7 to 14 day monitoring period to summarize the key observations. A final monitoring report will include monitoring methods and an analysis of observation results.

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8.0 APPENDIX A. TYPICAL HYDROKINETIC DEVICES THAT MAY BE TESTED AS PART OF THE PROJECT

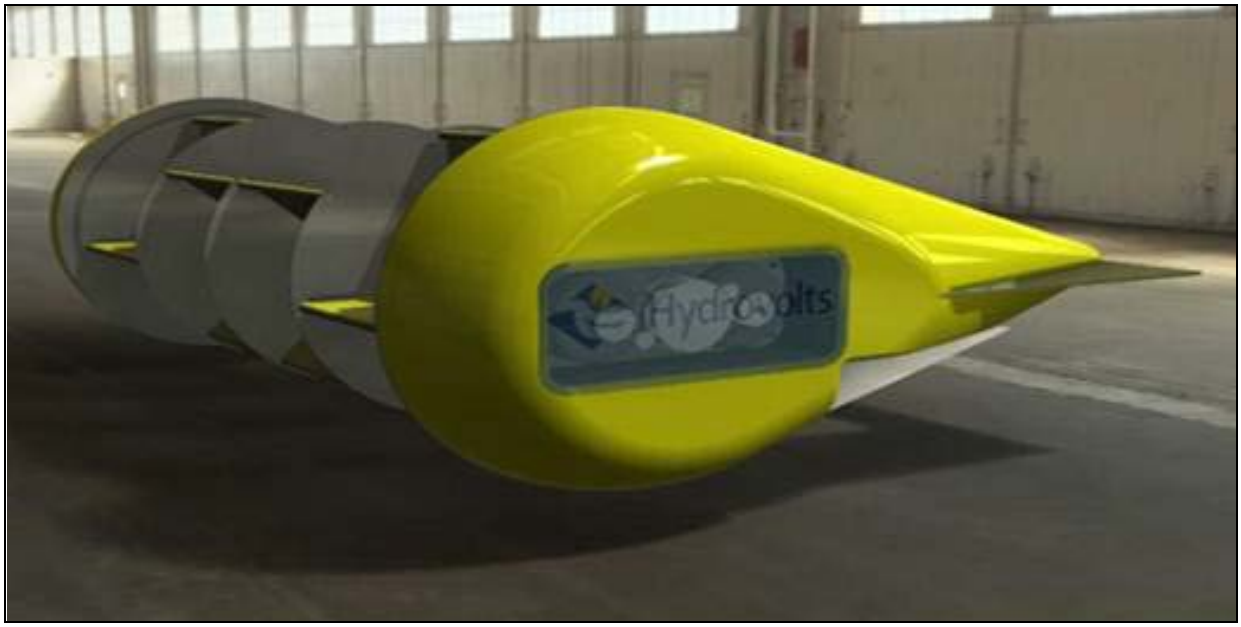
EnCurrent (25 kW) RISEC Device

- 5 kW model operated on the Yukon River near Ruby Alaska in 2008
- 25 kW model operated on the Yukon River near Eagle, Alaska in 2010
- Proposed location in Kvichak River channel – Centered 20 m off the left bank in a section of river 110 m wide
- Dimensions – Barge 7.0 m *w* x 13.7 m *l*, turbine height 5.4 m, rotor diameter 4.8 m, rotor height 2.4 m
- Power capacity – 25 kW
- Mooring – Anchored to river bottom
- Turbine design – Darrieus cross-flow 4 blade turbine
- Turbine velocity/pressure – 22.4 rpm @ 2.4 m/s water velocity with tips speed at 5.7 m/s
- Location of turbine in water column – Top – 0.3 m, Bottom – 2.1 m
- Blade material – Aluminum
- Effort required for shutdowns or removal – The turbine has an internal electric brake that activates automatically in the event of grid loss but can also be activated manually from either the barge or shore. The turbine assembly is mounted on a pivot with an electric winch assembly that allows it to be rotated out of the water from the barge. Entire rotation process takes about one minute. Full retrieval from the river is more complex and requires disconnecting the anchoring system and the power cable.
- Noise – transmission is located above water, noise expected to be low

Hydrovolts Class II RISEC Device

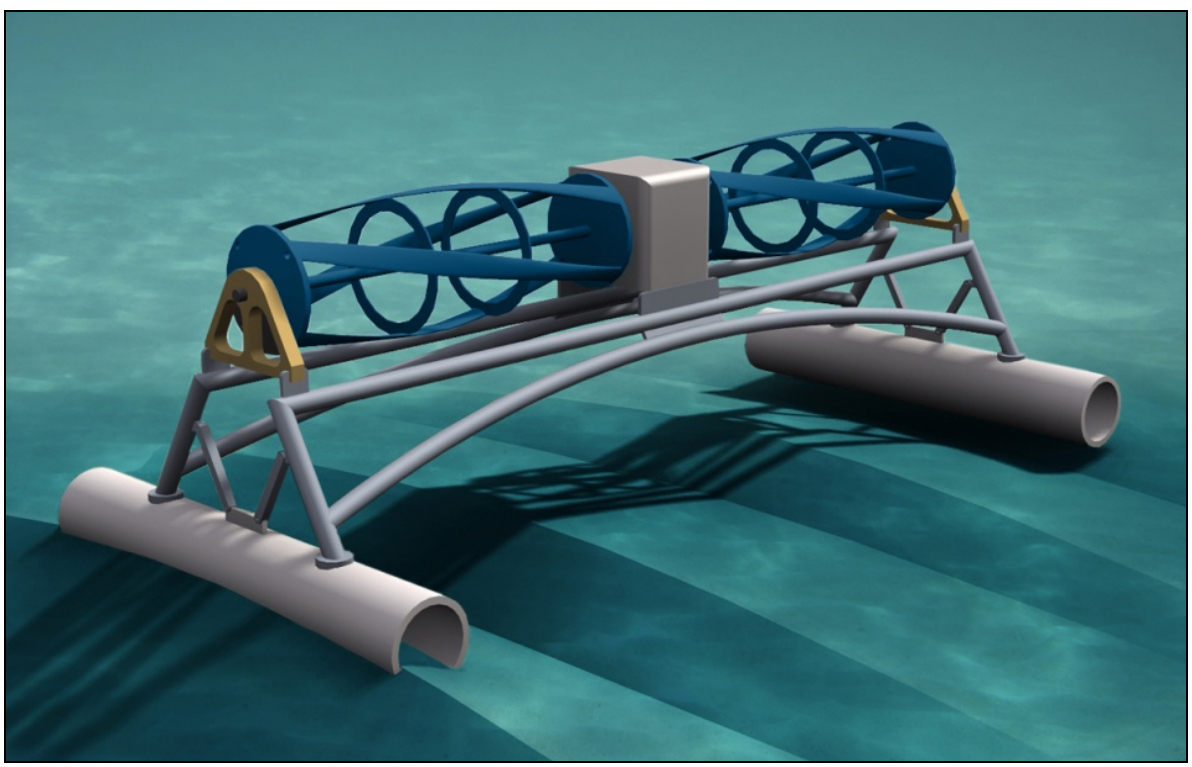
- Currently operating in irrigation and water supply canals
- Dimensions – 1.5 m high x 3 m wide
- Power capacity – 1.5 to 9 kW (at what river velocity?[a])
- Mooring – Anchored or positioned on river bottom
- Turbine design – Savonius
- Turbine velocity/pressure – (rpm, blade tip speed, pressure?)
- Location of turbine in water column – Can be positioned anywhere in the water column
- Blade material – ?
- Effort required for shutdowns or removal – ?
- Noise – ?

[a] No information from device manufacturer.



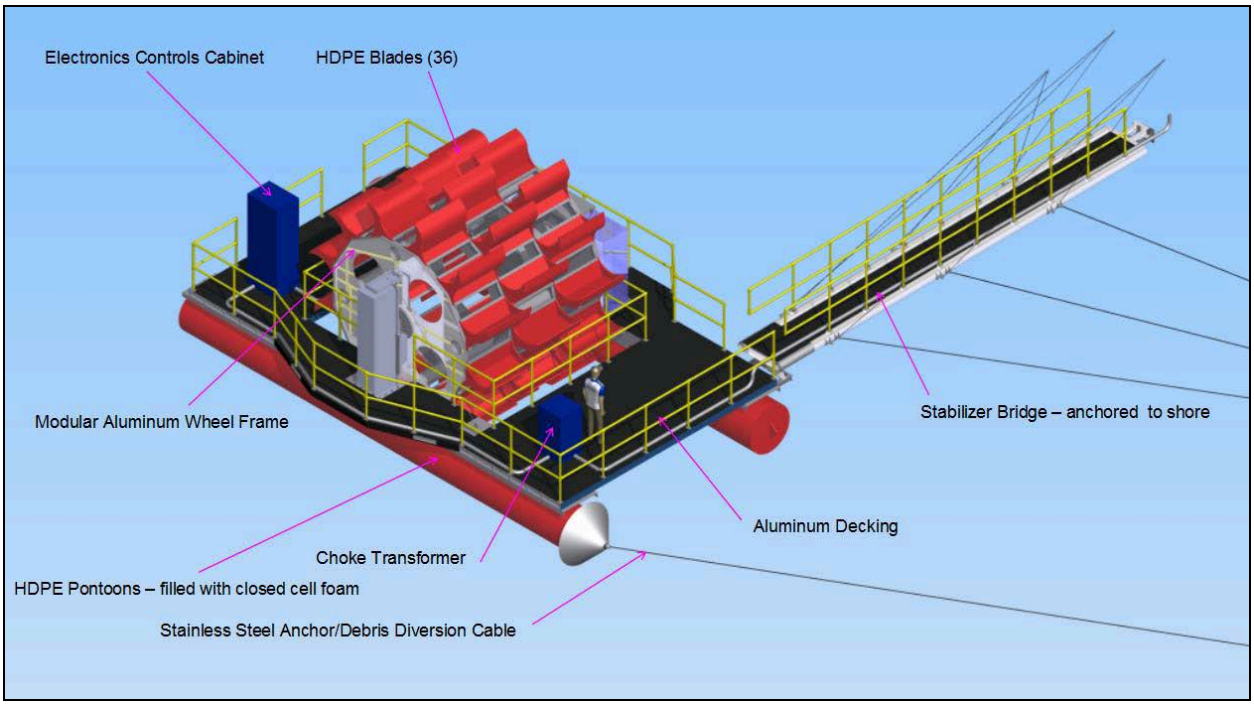
Ocean Renewable Power Company (ORPC) RISEC Device

- FERC Preliminary Permit P – 13883
- Proposed location in river channel – Centered at ~ 20 m off left bank, river width 110 m
- Dimensions – Total footprint 12.8 m *w* x 10.7 m *l* x 3.7 m *h* (exact height not known)
- Power capacity – 50 kW in a 6 knot current
- Mooring – River bottom
- Turbine design – Darrieus-Style turbine (11.9 m *w* x 1.5 m *h*)
- Turbine velocity – ~44 rpm @ 2 m/s water velocity with blade tip speed around 3.5 m/s
- Location of turbine in water column – submerged, depth not yet known
- Blade material – Carbon fiber composite
- Effort required to for shutdowns or removal – The bottom support frame is designed to float the entire system (minus the anchors), with the idea that by filling the main pontoons, the system will then sink to the bottom. By using compressed air to purge the pontoons, the entire system is designed to return to the surface. For deployment/retrieval, at a minimum the following equipment will be needed to deploy the anchors (barge/flexifloat and loader/winches/crane) and barge/tug for positioning the turbine.
- Noise – The turbine's magnet generator coverts the rotational motion of the turbine into direct current, without the use of a gear box. Noise levels measured in marine environments show device generated noise below ambient levels (Scientific Solutions Inc. 2011).



Whitestone RISEC Device

- FERC Preliminary Permit P – 13305 for Tanana River
- ADF&G Title 16 permit # FH11-III-0141 for Tanana River
- Proposed location in Kvichak river channel – Centered 20 m off the left bank in a section of river 110 m wide
- Dimensions – Total footprint on water 5.8 m *w* x 10.4 m *l*
- Power capacity – 100 kW
- Mooring – Shore
- Turbine design – Poncelet (fishwheel style) 3.7 m *w* x 4.9 m *dia*
- Turbine velocity/pressure – ~8 rpm @ 4.6m/s water velocity with blade tip at 40% of water velocity/0.51 psi at blade tips
- Location of turbine in water column – Surface down to 0.6 m depth, 3.7 m *w*
- Blade material – High Density polyethylene (HDPE)
- Effort required to for shutdowns or removal – Designed to shutdown easily. Estimated that 2 technicians can raise the wheel out of the water using a screw jack array in 3 minutes. Full retrieval from the river is more complex and requires disconnecting the anchoring system and the power cable.
- Noise – transmission is located above water, noise expected to be low



9.0 APPENDIX B. WILDLIFE RESOURCES

Marine Mammals

Harbor Seals

Lake Iliamna is home to one of the two known harbor seal (*Phoca vitulina*) populations that reside in freshwater lakes year-round (Hauser et al. 2008). Since 1991 there have been a number of aerial surveys to estimate the population of these seals, the estimates range from 105 in 2005 (National Marine Mammal Laboratory unpublished) to 321 in 1998 (Small et al. 2001). Distribution is concentrate near the islands located in the northeastern portion of the lake (Withrow and Yano 2009). Although there are no barriers to prevent the seals from leaving the lake there has been no indication that seals move up or down the river (Mathisen and Kline 1992). According to Hauser the seals feed predominately on spawning sockeye salmon during the summer and smaller resident fishes during the remainder of the year.

Although the chances of interactions between harbor seals and the device are thought to be rare, a set protocol will be followed in the event an interaction does occur. Harassment will be expressly prohibited and a standardized reporting protocol of each event will be established.

Beluga Whales

Beluga whales (*Delphinapterus leucas*) are an important subsistence resource in the Bristol Bay region, where the population has been estimated to be approximately 2000 animals (Frost and Lowry 2002). Due to the decline in sockeye returning to the Kvichak River in the late 90's and early 2000's State and Federal agencies have stepped up beluga research in that region of Bristol Bay. Belugas in both Kvichak Bay and Kvichak River are known to prey on the outmigrating sockeye smolts during the spring outmigration and the returning adults in the summer (Quakenbush 2002, Markowitz and Link 2006). In 2002 and 2003 a cooperative study was conducted by ADF&G to determine the potential impact these whales may have on the salmon population (Quakenbush 2003). By tagging and tracking whales and collecting stomach contents the researchers hoped to gain a better understanding of how much time the whales spend in the Kvichak River and how many smolts and adults they would consume during this period. In addition to this study aerial surveys were flown to estimate in-river abundance.

Of the estimated 300 – 400 belugas in the Kvichak River system, 5 of these were tagged with satellite transmitters in order to track their distribution. Tagging occurred in early May and the whales were tracked through August (Quakenbush 2003). The whales that stayed in the Kvichak River would only travel as far up as Levelock and one was detected just inside of the Alagnak River. It must be noted that in 2002 the tags were equipped with a stand-by mode that activated when the tags come out of saltwater (when these tags are used on seals and sea lions this saves battery life when they haulout). Therefore the tags may not have transmitted in the fresh water further up the Kvichak River. The author of the report stated that she did not know of any documented instances of whales traveling above Kaskanak Flats (Lori Quakenbush, pers. comm., 2011).

Although the chances of interactions between beluga whales and the device are thought to be rare, a set protocol will be followed in the event an interaction does occur. Harassment will be expressly prohibited and a standardized reporting protocol of each event will be established.

Bald Eagles

Bald Eagles (*Haliaeetus leucocephalus*) can be found throughout most of Alaska, with the majority congregating along the coastal regions (Dunn and Alderfer 2006). Sexually mature Bald Eagles typically nest around areas that may support a sufficient food supply (i.e., rivers, lakes or streams). In the vicinity of Igiugig there are several Bald Eagles that will use this area from early spring to late fall as a feeding and nesting area (AlexAnne Salmon, pers. comm., 2012). Based on a survey conducted by the Village of Igiugig there are currently 3 active nests in the area, none of which are closer than 201 m to any of the proposed sites (Figure 9).

The Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act were established to offer protection by minimizing harmful disturbances of human activities. A set of guidelines have been developed to benefit eagles and provide information to stakeholders on how best to avoid or minimize adverse impacts. These guidelines establish a distance criteria based on; scale of project (Category A – H), existing activity near the nest, and visibility buffers between the nest and the project (USFWS 2007). The proposed hydrokinetic project on the Kvichak River will fall under "Category A" and will be greater than 201 m from any nest in the area. In addition to the distance buffer, there are natural ecological barriers that prohibit the activity to be in full view. It is believed that the proposed activity will not differ from normal day-to-day activity that takes places in this section of river (i.e., sport and subsistence fishing, recreational boat traffic, float plane traffic, barge traffic).

Although the chances of interactions between Bald Eagles and the device are thought to be rare, a set protocol will be followed in the event an interaction does occur. Harassment will be expressly prohibited and a standardized reporting protocol of each event will be established.

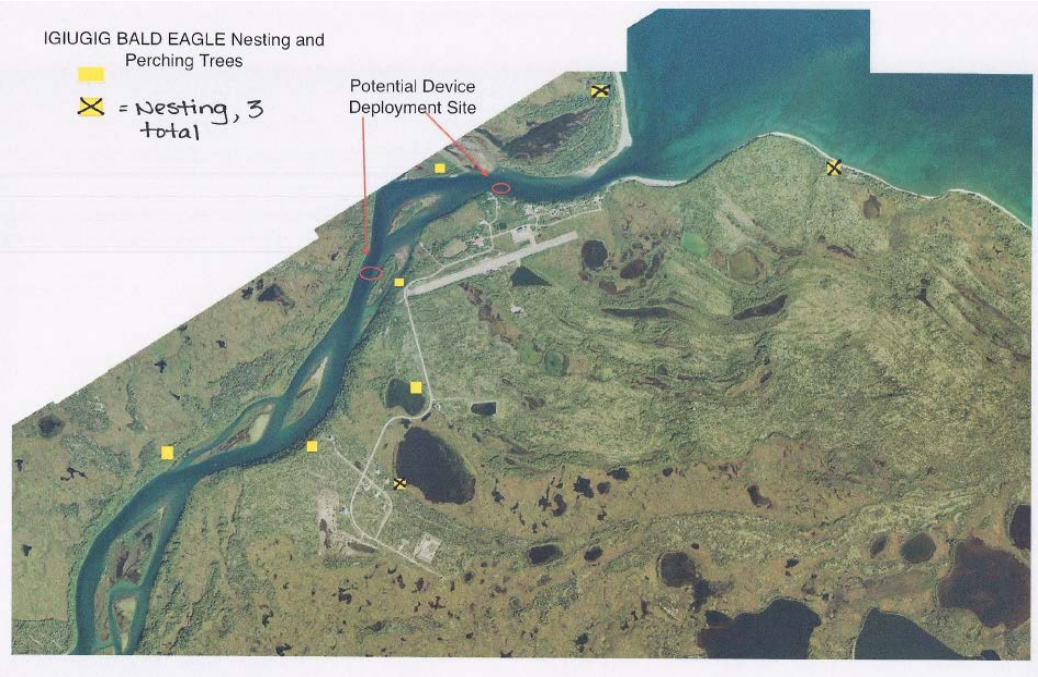


Figure 9. Map of study site showing Bald Eagle nesting locations. Data provided by Igiugig Village Council.

Terrestrial and Aquatic Mammals

Species that could be encountered in the vicinity of the project.

Order	Common Name	*Scientific Name*
Carnivora	Coyote	*Canis latrans*
	Gray Wolf	*Canis lupus*
	Red Fox	*Vulpes vulpes*
	Lynx	*Lynx canadensis*
	River Otter	*Lontra canadensis*
	Wolverine	*Gulo gulo*
	Marten	*Martes americana*
	Least Weasel	*Mustela nivalis*
	Mink	*Neovison vison*
	Black Bear	*Ursus americanus*
	Brown Bear	*Ursus arctos*
Artiodactyla	Moose	*Alces alces*
	Caribou	*Rangifer tarandus*
Rodentia	Beaver	*Castor canadensis*
	Muskrat	*Ondatra zibethicus*
	Porcupine	*Erethizon dorsatum*
Lagomorpha	Snowshoe Hare	*Lepus americanus*

Wright et al. 1985
Schroeder et al. 1987
Fall et al. 2006

Birds

Species that could be encountered in the vicinity of the project (Dunn and Alderfer 2006).

Avian Group	Common Name	Scientific Name
Waterfowl	Greater White-fronted Goose	*Anser albifrons*
	Lesser Snow Goose	*Anser caerulescens caerul.*
	Canada Goose	*Branta Canadensis*
	Tundra Swan	*Cygnus columbianus*
	Trumpeter Swan	*Cygnus buccinators*
	Mallard	*Anas platyrhynchos*
	Gadwall	*Anas strepera*
	Green-winged Teal	*Anas crecca*
	American Wigeon	*Anas Americana*
	Northern Pintail	*Anas acuta*
	Northern Shoveler	*Anas clypeata*
	Blue-winged Teal	*Anas discors*
	Canvasback	*Aythya valisineria*
	Redhead	*Aythya Americana*
	Ring-necked Duck	*Aythya collaris*
	Greater Scaup	*Aythya marila*
	Lesser Scaup	*Aythya affinis*
	Black Scoter	*Melanitta nigra*
	White-winged Scoter	*Melanitta fusca*
	Surf Scoter	*Melanitta perspicillata*
	Harlequin Duck	*Histrionicus histrionicus*
	Long-tailed Duck	*Clangula hyemalis*
	Barrow's Goldeneye	*Bucephala islandica*
	Common Goldeneye	*Bucephala clangula*
	Bufflehead	*Bucephala albeola*
	Common Merganser	*Mergus merganser*
	Red-breasted Merganser	*Mergus serrator*
	Hooded Merganser	*Lophodytes cucullatus*
Grouse and Ptarmigan	Ruffed Grouse	*Bonasa umbellus*
	Spruce Grouse	*Falcipennis Canadensis*
	White-tailed Ptarmigan	*Lagopus leucura*
	Rock Ptarmigan	*Lagopus muta*
	Willow Ptarmigan	*Lagopus lagopus*
	Sharp-tailed Grouse	*Tympanuchus phasianellus*

Avian Group	Common Name	Scientific Name
Loons	Red-throated Loon	*Gavia stellata*
	Pacific Loon	*Gavia pacifica*
	Common Loon	*Gavia immer*
Grebes	Horned Grebes	*Podiceps auritus*
	Red-necked Grebe	*Podiceps grisegena*
Raptors	Osprey	*Pandion haliaetus*
	Northern Harrier	*Circus cyaneus*
	Golden Eagle	*Aquila chrysaetos*
	Bald Eagle	*Haliaeetus leucocephalus*
	Sharp-shinned Hawk	*Accipiter striatus*
	Northern Goshawk	*Accipiter gentilis*
	Red Tailed Hawk	*Buteo jamaicensis*
	Rough-legged Hawk	*Buteo lagopus*
	American Kestrel	*Falco sparverius*
	Merlin	*Falco columbarius*
	Peregrin Falcon	*Falco peregrines*
	Gyrfalcon	*Falco rusticolus*
	Short-eared Owl	*Asio flammeus*
	Great Horned Owl	*Bubo virginianus*
	Great Gray Owl	*Strix nebulosa*
	Northern Hawk Owl	*Surnia ulula*
	Boreal Owl	*Aegolius funereus*
Cranes	Sandhill Crane	*Grus Canadensis*
Shorebirds	Black-bellied Plover	*Pluvialis squatarola*
	American Golden-Plover	*Pluvialis dominica*
	Pacific Golden-Plover	*Pluvialis fulva*
	Semipalmated Plover	*Charadrius semipalmatus*
	Killdeer	*Charadrius vociferous*
	Lesser Yellowlegs	*Tringa flavipes*
	Greater Yellowlegs	*Tringa melanoleuca*
	Solitary Sandpiper	*Tringa solitaria*
	Wandering Tattler	*Tringa incana*
	Spotted Sandpiper	*Actitis macularia*
	Whimbrel	*Numenius phaeopus*
	Hudsonian Godwit	*Limosa haemastica*

Avian Group	Common Name	Scientific Name
	Ruddy Turnstone	*Arenaria interpres*
	Surfbird	*Aphriza virgata*
	Dunlin	*Calidris alpine*
	Semipalmated Sandpiper	*Calidris pusilla*
	Western Sandpiper (u)	*Calidris mauri*
	Least Sandpiper	*Calidris minutilla*
	Upland Sandpiper (u)	*Bartramia longicauda*
	Short-billed Dowitcher	*Limnodromus griseus*
	Long-billed Dowitcher	*Limnodromus scolopaceus*
	Wilson's Snipe	*Gallinago delicate*
	Red-necked Phalarope	*Phalaropus lobatus*
Gulls and Terns	Bonaparte's Gull	*Larus Philadelphia*
	Mew Gull	*Larus canus*
	Herring Gull	*Larus argentatus*
	Glaucous-winged Gull	*Larus glaucescens*
	Arctic Tern	*Sterna paradisaea*
Kingfishers	Belted Kingfisher	*Megaceryle alcyon*
Woodpeckers	Northern Flicker	*Colaptes auratus*
	Downy Woodpecker	*Picoides pubescens*
	Hairy Woodpecker	*Picoides villosus*
	American Three-toed Wood.	*Picoides dorsalis*
	Black-backed Woodpecker	*Picoides arcticus*
Corvids	Northern Shrike	*Lanius excubitor*
	Steller's Jay (u)	*Cyanocitta stelleri*
	Gray Jay	*Perisoreus Canadensis*
	Black-billed Magpie	*Pica pica*
	Common Raven	*Corvus corax*
Passerines	Olive-sided Flycatcher	*Contopus cooperi*
	Alder Flycatcher	*Empidonax alnorum*
	Hammonds Flycatcher (u)	*Empidonax hammondii*
	Horned Lark	*Eremophila alpestris*
	Tree Swallow	*Tachycineta bicolor*

Avian Group	Common Name	Scientific Name
	Violet-green Swallow	*Tachycineta thalassina*
	Bank Swallow	*Riparia riparia*
	Cliff Swallow	*Petrochelidon pyrrhonota*
	Black-capped Chickadee	*Poecile atricapillus*
	Boreal Chickadee	*Poecile hudsonicus*
	Red-breasted Nuthatch	*Sitta Canadensis*
	American Dipper [(u)]	*Cinclus mexicanus*
	Golden-crowned Kinglet [(u)]	*Regulus satrapa*
	Ruby-crowned Kinglet	*Regulus calendula*
	Arctic Warbler	*Phylloscopus borealis*
	Gray-cheeked Thrush	*Catharus minimus*
	Swainson's Thrush	*Catharus ustulatus*
	Hermit Thrush	*Catharus guttatus*
	Varied Thrush	*Ixoreus naevius*
	American Robin	*Turdus migratorius*
	American Pipit	*Anthus rubescens*
	Bohemian Waxwing	*Bombycilla garrulous*
	Orange-crowned Warbler	*Vermivora celata*
	Yellow-rumped Warbler	*Dendroica coronate*
	Townsend's Warbler [(u)]	*Dendroica townsendi*
	Blackpoll Warbler	*Dendroica striata*
	Yellow Warbler	*Dendroica petechia*
	Wilson's Warbler	*Wilsonia pusilla*
	Northern Waterthrush	*Seiurus noveboracensis*
	American Tree Sparrow	*Spizella arborea*
	Chipping Sparrow [(u)]	*Spizella passerine*
	Fox Sparrow	*Passerella iliaca*
	Savannah Sparrow	*Passerculus sandwichensis*
	Lincoln's Sparrow	*Melospiza lincolnii*
	White-crowned Sparrow	*Zonotrichia leucophrys*
	Golden-crowned Sparrow	*Zonotrichia atricapilla*
	Dark-eyed Junco	*Junco hyemalis*
	Smith's Longspur [(u)]	*Calcarius pictus*
	Lapland Longspur	*Calcarius lapponicus*
	Snow Bunting	*Plectrophenax nivalis*
	Red-winged Blackbird [(u)]	*Agelaius phoeniceus*
	Rusty Blackbird	*Euphagus carolinus*
	Gray-crowned Rosy-finch	*Leucosticte tephrocotis*

Avian Group	Common Name	Scientific Name
	White-winged Crossbill	*Loxia leucoptera*
	Pine Grosbeak	*Pinicola enucleator*
	Pine Siskin	*Carduelis pinus*
	Common Redpoll	*Carduelis flammea*
	Hoary Redpoll	*Acanthis hornemanni*

(u) unlikely to be observed

Wildlife Sighting Report

Observer Name: _____ Affiliation: _____
Local Alaska Time Date: _____ Time: _____
Species: _____ Location: _____
Description of encounter:

Observer Name: _____ Affiliation: _____
Local Alaska Time Date: _____ Time: _____
Species: _____ Location: _____
Description of encounter:

Observer Name: _____ Affiliation: _____
Local Alaska Time Date: _____ Time: _____
Species: _____ Location: _____
Description of encounter:

Observer Name: _____ Affiliation: _____
Local Alaska Time Date: _____ Time: _____
Species: _____ Location: _____
Description of encounter:

Marine Mammal Sighting Report

Observer Name: _____
Affiliation: _____
Species: **Beluga/Harbor Seal**

Local Alaska Time Date: _____ Time: _____

Location: _____

Description of the Marine Mammal Sighting

Weather conditions: _____

Number of animals: _____

Behavior: _____

Duration of encounter: _____

Distance from device: _____

Description of encounter

Appendix B Wildlife References

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10.0 APPENDIX C. REGULATORY AGENCY COMMENTS ON THE MONITORING PLAN

Agency Correspondence Exhibit A

From: Kimberly_Klein@fws.gov [mailto:Kimberly_Klein@fws.gov]
Sent: Friday, January 13, 2012 12:07 PM
To: Guy Wade; bnass@lgl.com; wprice@ak.net
Cc: Ellen_Lance@fws.gov; Betsy_McCracken@fws.gov
Subject: Re: Fw: Igiugig RISEC Project No. 13511 Agency Consultation Meeting Request

Please see the attached letter regarding the potential impacts of the Igiugig RISEC project on threatened and endangered species listed under the Endangered Species Act. Call or reply with questions or if a hard copy is needed. Thank you.

(See attached file: 2012-0028_Igiugig Kvichak River Hydro_SL.pdf)
Kimberly Klein
Endangered Species Biologist
USFWS/AFWFO
605 W. 4th Ave. Room G-61
Anchorage, AK 99501
(907) 271-2066

Agency Correspondence Exhibit B

-------- Original Message --------
Subject: RE: Fw: Igiugig RISEC Project No. 13511 Agency Consultation Meeting Request
Date: Tue, 17 Jan 2012 09:18:35 -0900
From: Kimberly_Klein@fws.gov
To: Guy Wade <gwade@lgl.com>
CC: Betsy_McCracken@fws.gov <Betsy_McCracken@fws.gov>, bnass@lgl.com <bnass@lgl.com>, wprice@ak.net <wprice@ak.net>

Thank you Guy, please also consider that the comments sent last week address threatened and endangered species only, and that the FWS will continue to work with you to address other potential issues, including fish and migratory birds.
Thanks again.

Kimberly Klein
Endangered Species Biologist
USFWS/AFWFO
605 W. 4th Ave. Room G-61
Anchorage, AK 99501
(907) 271-2066

Agency Correspondence Exhibit C

From: Schwanke, Craig J (DFG) [mailto:craig.schwanke@alaska.gov]
Sent: Friday, January 13, 2012 10:44 AM
To: Guy Wade
Subject: RE: Agenda for the Igiugig RISEC Project No. 13511 Consultation

Guy,
Good job yesterday. I look forward to following this study for the next couple years.

In your draft plan on page 9 you state "Reported sport harvest of sockeye in the Bay is surprising low; for example in 2008 no harvest was reported (Clark 2005)." I'm not sure what you mean by the "Bay", but there was documented harvest with the SWHS for the Kvichak River in 2008 (2,777 sockeye). Let me know if you need more information for the final plan.

Craig Schwanke
Assistant Area Management Biologist
Alaska Department of Fish and Game
Division of Sport Fish
Bristol Bay
(907) 842-2427

Agency Correspondence Exhibit D

From: Betsy_McCracken@fws.gov [mailto:Betsy_McCracken@fws.gov]
Sent: Tuesday, January 31, 2012 10:55 AM
To: Bill Price
Subject: Re: Kvichak River RISEC Project- FWS EAGLE INFORMATION

Hi Bill,

Thanks for the email, and the follow up phone call. Here is some generic and preliminary information related to eagles that will be useful for your project development to consider, and provide to the USFWS.

1) It would be helpful if the project sponsors provided approximate distances from the identified eagles nest within the context of the proposed project activities (i.e., blasting, drilling, vegetaion clearing, etc); and a time frame for each activity type (i.e., are activities proposed during the mating season?)

2) Will the project entail other activities or locations likely to "take" eagles and/or their nests

(i.e., laydown sites, fuel storage, construction of maintenances roads, pump stations etc)?

As an FYI, permit processing for a simple standard take permit is approximately 90 days (including tribal, SHPO, and ADFG consultations) from the time a COMPLETE permit application is submitted. Larger or controversial projects requiring completion of an EA or EIS may take 6 months to 1.5 years. The permit application fee is $500.00 and the permit tenure is up to 5 years.

Also, here is the link for the Alaska Region Eagle Program information

http://alaska.fws.gov/eaglepermit/index.htm

If you would please make sure that this information gets to all the appropriate project contacts, we would appreciate it. There is a lot of information at the site including definitions of "take", the recently published (2009) Federal Register on Eagle Permits, survey responsibilities, potential mitigation requirements, recommendations for avoidance and minimization, and related links.

Please feel free to contact the Service as you navigate the Eagle Permit process. We look forward to working with the Watana Project staff as the project evolves.

The FWS will integrate the eagle review into our larger Kvichak River hydropower review in order to best coordinate with the project sponsors. Additional questions may arise, and further consultation may be necessary related to eagles for this project depending on survey results.
I hope this information is helpful.

I will provide you additional information related to other resources under FWS jurisdiction per your email request below.

Thank you very much, and please feel free to contact project staff with any concerns.

Betsy
Betsy W. McCracken

Fishery Biologist
Conservation Planning Assistance
Ecological Services
US Fish and Wildlife Service/Region 7/Anchorage Field Office
Betsy_McCracken@fws.gov
(907) 271 - 2783

Agency Correspondence Exhibit E

From: Betsy_McCracken@fws.gov
To: Guy Wade
Subject: Fw: Eagle Permits
Date: Friday, February 10, 2012 8:38:33 AM
Attachments: Letter responding to inquiries 1-2010.pdf

Hi Guy,
Jordan Muir at the USFWS Regional Office on Tudor Road in Anchorage is our "eagle guy". His contact is included in his email below. I am forwarding you links to information that will be of interest to you for your project related to eagles.

Please feel free to contact either Jordan or I with any additional questions. I hope this helps!
Take care,
Betsy

Betsy W. McCracken
Fishery Biologist
Conservation Planning Assistance
Ecological Services
US Fish and Wildlife Service/Region 7/Anchorage Field Office
Betsy_McCracken@fws.gov
(907) 271 - 2783

----- Forwarded by Betsy McCracken/R7/FWS/DOI on 02/10/2012 08:35 AM -----

Jordan Muir/R7/FWS/DOI
02/02/2012 10:50 AM
To Betsy McCracken/R7/FWS/DOI@FWS
cc
Subject Eagle Permits

Betsy,
Thanks for coming over to chat yesterday morning. As you pointed out I'm sure we'll be talking much more. Per our meeting I am forwarding a number of links and documents relevant to eagle issues and permitting, including:

National Bald Eagle Management Guidelines - Although developed prior to the promulgation of the new Eagle Permit Rule this document provides good information on activity specific buffer distances that should be maintained around nests to avoid disturbance (considered take under BGEPA).
(http://www.fws.gov/pacific/eagle/NationalBaldEagleManagementGuidelines.pdf)

USFWS' 2009 Final Environmental Assessment for the new Eagle Permit Rule - This document provides valuable information on how annual thresholds were developed and discusses

the importance of mitigation and monitoring as permit requirements.
(http://alaska.fws.gov/eaglepermit/pdf/environmental_assessment.pdf)
USFWS' Final Rule for the Eagle/Eagle Nest Take Permits - provides specific information on activity types that qualify for permits, discusses avoidance and minimization requirements and compensatory mitigation triggers
(http://www.fws.gov/migratorybirds/CurrentBirdIssues/BaldEagle/Final%20Disturbance%20Rule%209%20Sept%202009.pdf)

Additional information can be found on the R7 Eagle Permit Program Web Page:
(http://alaska.fws.gov/eaglepermit/index.htm)

Eagle Take Application:
(http://www.fws.gov/forms/3-200-71.pdf)

Eagle Nest Take Application:
(http://www.fws.gov/forms/3-200-72.pdf)

In addition, I've attached a letter Steve Brockmann (Ecological Services - Juneau) developed as a standard response to eagle inquiries (see below). I'm working to finish review of raptor survey reports provided by Susitna-Watana and Donlin Mine project proponents. I'll forward my rough notes to you ASAP.

Thanks, Betsy, and don't hesitate to contact me at any time if I can provide any additional information.
-Jordan

Jordan J. Muir
USFWS Region 7 Eagle Permit Biologist
1011 East Tudor Road, MS-201
Anchorage, Alaska 99503
Office: 907-786-3503
Fax: 907-786-3927

-----Original Message-----
From: Cassie_Thomas@nps.gov [mailto:Cassie_Thomas@nps.gov]
Sent: Tuesday, January 31, 2012 5:44 PM
To: Bill Price
Subject: Re: FW: Igiugig RISEC Project No. 13511 Consultation Meeting Minutes

Hi Bill,

As I mentioned on the phone, placement of the devices near Igiugig under a FERC pilot license appears to be unlikely to create unacceptable recreational or aesthetic impacts, provided the array is safely moored, tethered or anchored, and its location properly marked for navigational safety, as may be required by other agencies (e.g. Coast Guard).

One designated Wild and Scenic River, the Tlikakila, is located well upstream of Igiugig. FYI, I'm attaching a Google Earth file with this river's location. It is a tributary to Lake Clark so there would be no impact on the WSR unless the RISEC project diminished salmon populations in the Tlikakila, and again it seems unlikely that this kind of adverse effect would be permitted under a pilot license or tolerated by the residents of Igiugig.

(See attached file: Tlikakila Wild River.kmz)

Meanwhile I've forwarded your meeting notes to staff at Lake Clark and Katmai National Parks in case they have questions or comments about the monitoring plans.

Thank you for giving me this status update on the project and let me know if you have any more questions --

Cassie Thomas

Program Analyst
WASO Park Planning & Special Studies Division AK Coordinator, NPS Hydropower Assistance Program

907 350-4139
11081 Glazanof Dr., Rm 108
Anchorage AK 99507

Agency Correspondence Exhibit F

From: Betsy_McCracken@fws.gov
To: Guy Wade
Subject: Fw: Eagle Permits
Date: Friday, February 10, 2012 8:38:33 AM
Attachments: Letter responding to inquiries 1-2010.pdf

Hi Guy,
Jordan Muir at the USFWS Regional Office on Tudor Road in Anchorage is our "eagle guy". His contact is included in his email below. I am forwarding you links to information that will be of interest to you for your project related to eagles.

Please feel free to contact either Jordan or I with any additional questions. I hope this helps!
Take care,
Betsy

Betsy W. McCracken
Fishery Biologist
Conservation Planning Assistance
Ecological Services

US Fish and Wildlife Service/Region 7/Anchorage Field Office
Betsy_McCracken@fws.gov
(907) 271 - 2783

----- Forwarded by Betsy McCracken/R7/FWS/DOI on 02/10/2012 08:35 AM -----
Jordan Muir/R7/FWS/DOI
02/02/2012 10:50 AM
To Betsy McCracken/R7/FWS/DOI@FWS
cc
Subject Eagle Permits

Betsy,
Thanks for coming over to chat yesterday morning. As you pointed out I'm sure we'll be talking much more. Per our meeting I am forwarding a number of links and documents relevant to eagle issues and permitting, including:

National Bald Eagle Management Guidelines - Although developed prior to the promulgation of the new Eagle Permit Rule this document provides good information on activity specific buffer distances that should be maintained around nests to avoid disturbance (considered take under BGEPA).
(http://www.fws.gov/pacific/eagle/NationalBaldEagleManagementGuidelines.pdf)

USFWS' 2009 Final Environmental Assessment for the new Eagle Permit Rule - This document provides valuable information on how annual thresholds were developed and discusses the importance of mitigation and monitoring as permit requirements.
(http://alaska.fws.gov/eaglepermit/pdf/environmental_assessment.pdf)

USFWS' Final Rule for the Eagle/Eagle Nest Take Permits - provides specific information on activity types that qualify for permits, discusses avoidance and minimization requirements and compensatory mitigation triggers
(http://www.fws.gov/migratorybirds/CurrentBirdIssues/BaldEagle/Final%20Disturbance%20Rule%209%20Sept%202009.pdf)

Additional information can be found on the R7 Eagle Permit Program Web Page:
(http://alaska.fws.gov/eaglepermit/index.htm)

Eagle Take Application:
(http://www.fws.gov/forms/3-200-71.pdf)

Eagle Nest Take Application:
(http://www.fws.gov/forms/3-200-72.pdf)

In addition, I've attached a letter Steve Brockmann (Ecological Services - Juneau) developed as a standard response to eagle inquiries (see below). I'm working to finish review of raptor survey reports provided by Susitna-Watana and Donlin Mine project proponents. I'll forward my rough notes to you ASAP.

Thanks, Betsy, and don't hesitate to contact me at any time if I can provide any additional information.
-Jordan

Jordan J. Muir
USFWS Region 7 Eagle Permit Biologist
1011 East Tudor Road, MS-201
Anchorage, Alaska 99503
Office: 907-786-3503
Fax: 907-786-3927

From: Jordan_Muir@fws.gov
To: Guy Wade
Cc: Betsy_McCracken@fws.gov
Subject: Re: Igiugig hydrokinetic project Bald Eagle Question
Date: Wednesday, February 15, 2012 3:08:39 PM

Guy,
I appreciate the notice regarding the Igiugig hydrokinetic project. It's always nice to see people thinking pro-actively about potential impacts to eagles. The Eagle Permit Program was established in 2009 and somewhat unique in that it is co-managed by Conservation Planning Assistance (CPA) and Migratory Bird Management (MBM). The CPA Office is the first point of contact for project proponents concerned about impacts to eagles. CPA works with project proponents to: (1) assess the likelihood and nature of any potential take; (2) assist in developing measures to avoid and minimize take; and (3) help determine if avoiding take is impracticable. If take is likely despite avoidance and minimization measures CPA will recommend project proponents contact the MBM Permit Office (my office) to apply for a take permit. Consequently, I would recommend contacting CPA first to discuss potential impacts to eagles associated with construction and operation of the Igiugig hydrokinetic project. The Anchorage CPA office can be reached at 907-271-2888.

In general, bald eagles, their eggs, and their nests are protected throughout the United States by the Bald and Golden Eagle Protection Act, and by the Migratory Bird Treaty Act. These federal laws forbid “take”, which is defined to include pursue, hunt, shoot, shoot at, poison, wound, kill, capture, trap, collect, possess, molest, or disturb. Eagles can be sensitive to habitat alterations and disruptive activities near their nests, leading, in some cases, to nest abandonment, mortality of eggs or young, or destruction of a nest. To help landowners, developers, and others avoid such impacts, the U.S. Fish and Wildlife Service has developed guidelines for management of nest sites. Compliance with the guidelines is voluntary, not mandatory. Those who follow the guidelines reduce the risk of impacting eagles, and of violating the laws that protect these birds. Those who do not follow the guidelines increase the risk of impacts and of prosecution if “take” occurs. The National Bald Eagle Management Guidelines can be downloaded at: http://www.fws.gov/migratorybirds/issues/BaldEagle/NationalBaldEagleManagementGuidelines.pdf

Additional help determining whether your activity may disturb eagles, and suggestions for avoiding disturbance, are available at: (http://alaska.fws.gov/birds/guidelines/index.html).

Additional information is available at our eagle permit website:
(http://alaska.fws.gov/eaglepermit/permit.htm).

As you pointed out, the Fish and Wildlife Service has created an interactive map viewer for landowners, planners, or others who need to know locations of eagle nests in Alaska. The viewer shows approximate locations of nests that the Fish and Wildlife Service has documented over many years. Some of the nests shown may no longer exist; others are not shown on the map because they were not detected during surveys or were built since the last surveys were completed. Some areas have never been formally surveyed, and some areas have not been surveyed for many years, so many additional nests probably exist. In most cases, the symbols on the map are not exactly where the nest is located, but represent our best approximation.

Those interested in a particular site should not rely entirely on this map, but should check the actual project site itself for nests.

I hope this helps and don't hesitate to contact me if I can provide any additional information.
-Jordan
P.S. I am CCing Betsy McCracken at the Anchorage CPA office on this e-mail.

Jordan J. Muir
USFWS Region 7 Eagle Permit Biologist
1011 East Tudor Road, MS-201
Anchorage, Alaska 99503
Office: 907-786-3503
Fax: 907-786-3927

Agency Correspondence Exhibit G

MEMORANDUM State of Alaska

TO: Kate Harper
Habitat Division
Anchorage

DATE: January 26, 2012

FAX NO: 267-2442

TELEPHONE NO: 267-2237

FROM: Fred West
Fisheries Biologist
Commercial Fisheries Division/Region II
Bristol Bay

SUBJECT: Comments on Igiugig RISEC project

I am one of the assistant research biologists for the Bristol Bay area and run the ASL sampling portion of smolt assessment on the Kvichak River. Following are my list of comments pertaining to each of the devices as they pertain to both adult and juvenile salmon and resident species.

Hopefully an assessment can be made at the site prior to any equipment going in so it can be determined what species use the area in question. As was suggested at the meeting, Snorkel surveys, shore based underwater cameras, device mounted cameras, and a shore based tower would be ideal methods to assess adult and juvenile salmon passage before and during deployment of devices. Seems resident species could be observed this way as well. Tower observations can be limiting as how far out one can see because of sun glare and ripples. One should be able to observe near shore passage without any trouble.

It's unfortunate that a device won't be deployed during this year's smolt outmigration to determine impact but hopefully they can get an idea of what uses the site before a device is deployed. Smolt have a small window (2 weeks) when they emigrate out in very large groups that cover almost the entire river. So depending on the devise and the impact it has on smolt, it could be shut down during peak passage if it was deemed harmful to smolt.

The ORPC unit concerns me the most as both adults and juvenile smolt could be impacted. I think most adults and resident species with avoid the device but it is rather large and the blades can spin up to 75 rpm. 3 spine and 9 spine Stickleback are also of concern since they can be found in similar environment as smolt. Either an incline plane trap or a larger fyke net/tow net system would be a good way to assess what kind of condition they would be in after passing through the device.

The ABS/New Energy unit is of a lesser concern than the ORPC unit but the blades can still spin up to 22 rpm so curious what impact this would have. I think most adults and residents would avoid the device but similar assessment methods could be used as those above.

The other four devices seem pretty benign in comparison the first two so all the assessment and monitoring methods would seem to work for these as well.

Agency Correspondence Exhibit H

From: Susan Walker
To: Bill Price
Cc: Eric Rothwell; Harper, Kate J (DFG); Haught, Stormy B (DFG); Fred (DFG; monte.miller@alaska.gov; Romsland,
Renee C (DNR); Betsy_McCracken@fws.gov; Kimberly_Klein@fws.gov; Roberta K POA; krissy.plett@alaska.gov;
karlhill907@yahoo.com; Schwanke, Craig J (DFG); debby.burwen@alaska.gov; christianna.colles@alaska.gov;
barbara.mahoney@noaa.gov; slim.morstad@alaska.gov; robin.swinford@alaska.gov; jennifer_spegon@fws.gov;
Fetters, Alan; AlexAnna Salmon; Steven Stassel; Bryan Nass; Guy Wade
Subject: Re: Igiugig RISEC Project No. 13511 Consultation Meeting Minutes
Date: Thursday, February 09, 2012 5:46:39 PM

Dear Bill:
Thank you for providing detailed background information to NMFS and other stakeholders regarding the proposed spring launch of the Iguigig RISEC project at the recent meeting on the proposed project.

NMFS agrees that the Iguigig site provides environmental conditions ideal for testing in-river turbine devices, namely clear water, a lack of debris at the surface and in the water column, minimal bedload, as well as good background information on current profiling and fisheries use at the site and a readily available power transmission connection into the small Iguigig power system.

Although the AEA is undergoing the FERC's hydrokinetic pilot licensing process for the Iguigig project, the AEA proposes applying for FERC's "Verdant Rule" waiver in order for the project to begin testing devices in the waters of the Kvichak River at Iguigig during this coming summer season. NMFS anticipates that the AEA will require U.S. Army Corps of Engineers permits under Section 10 of the Rivers and Harbors Act as the federal action necessary to permit placement of devices in the water. NMFS will comment to the Corps during that process and expects that this will be an expedited process using a Nationwide Permit application.

To provide AEA with advance notice of NMFS concerns for possible impacts to Essential Fish Habitat for salmon and marine mammals, and likely recommendations to the Corps to avoid or minimize any impacts, NMFS requests the following actions:

-Provide a summary of existing environmental studies, specifically ones directed towards device impacts on fish and fish habitat. Even if these studies are not conducted on Alaskan species there may be relevant information useful for assessing likely project effects and developing conservation recommendations.

-The footprint of each device during different flows and times of the year should be compared to the timing of species and life-stage of fish present. Specifically we are concerned about the footprint of these individual devices during lower flow periods, it will be useful to compare the

footprint as compared to the total water column and compared to the cross-sectional area of the channel at the operation flow range.

-Provide a summary table of the cross-sectional use of the project area used for fish migration by species and lifestage. Information was provided during the meeting that implied which parts of the channel adult and juvenile sockeye and Chinook used but this will be useful to see in comparison to the footprint of each device at the flows likely to be encountered.

-Avoid placing or operating in-river turbine devices during the important sockeye smolt outmigration period that occurs just after ice-out in May. FERC's pilot licensing process is intended for use in non-sensitive areas. NMFS considers this site during the sockeye smolt outmigration period to be an especially important and sensitive site, as is the adult migration to spawning habitat in and above the lake. Until more data are gathered regarding the possible direct and indirect effects of the devices we recommend avoiding this period when ADF&G records document that as many as 15 million sockeye smolt migrate through this section of river in a single day.

-In addition, a fisheries monitoring plan of direct and indirect device interactions with adult sockeye and other salmonids of all life-stages should be developed.

-Lake Illiamna supports a unique freshwater population of harbor seals. Data provided by AEA to NMFS indicates that seals do not use the Kvichak River, but are found in the island areas in the north east portion of the lake, and that the seals are year-round residents. NMFS advises that a monitoring plan be developed to ensure that seals do not move through the project site and are not attracted to the tidal turbines or otherwise adversely affected.

Please contact me if you have any questions regarding NMFS recommendations -
Sincerely,
Sue Walker

NMFS Hydropower Coordinator
Alaska Region

Appendix C References

Clark, J.H. 2005 Abundance of sockeye salmon in the Alagnak River system of Bristol Bay Alaska. Fishery Manuscript No. 05-01. Alaska Dept. Fish and Game. Anchorage, AK.

11.0 APPENDIX D. RESPONSE TO COMMENTS ON MONITORING PLAN

Response to Agency Correspondence Exhibit A

-------- Original Message --------

Subject: RE: Fw: Igiugig RISEC Project No. 13511 Agency Consultation Meeting Request
Date: Mon, 16 Jan 2012 18:55:28 +0000
From: Guy Wade <gwade@lgl.com>
To: Kimberly_Klein@fws.gov <Kimberly_Klein@fws.gov>, bnass@lgl.com <bnass@lgl.com>, wprice@ak.net <wprice@ak.net>
CC: Ellen_Lance@fws.gov <Ellen_Lance@fws.gov>, Betsy_McCracken@fws.gov <Betsy_McCracken@fws.gov>

Kimberly,
Thank you for the prompt response regarding the Section 7 consultation. At this point we don't anticipate the need for overhead power transmission lines but in the event they are used your comments will be taken into consideration. If the project description changes (we don't anticipate this) we will be sure to notify US Fish and Wildlife of the changes as this may require further consultation.
Thank you,
Guy Wade

Cc
Bill Price, Project Engineer – AEE
Bryan Nass, Senior Fisheries Biologist - LGL

Response to Agency Correspondence Exhibit B

-------- Original Message --------
Subject: RE: Agenda for the Igiugig RISEC Project No. 13511 Consultation
Date: Thu, 2 Feb 2012 20:04:01 +0000
From: Guy Wade <gwade@lgl.com>
To: Schwanke, Craig J (DFG) <craig.schwanke@alaska.gov>
CC: jason.dye@alaska.gov <jason.dye@alaska.gov>, Bryan Nass <bnass@lgl.com>, Bill Price <wprice@ak.net>, Harper, Kate J (DFG) <kate.harper@alaska.gov>

Craig,
Thank you for the comments regarding the sockeye sport fish harvest on the Kvichak River. We had since corrected the error and will include the following text in the report.

"Subsistence fishing for sockeye salmon in Bristol Bay has occurred since inhabitance and continues to be an important source of protein for local residents (Morstad et al. 2010). In 2009, the subsistence harvest of sockeye for the Kvichak River/Iliamna Lake sub-district totaled 46,772 from 187 permits, and in the Igiugig region totaled 1,071 from 5 permits (Salomone et al. 2011). In addition to the subsistence fishery, sockeye salmon have been an essential segment of

the sport fishing industry for that region. From 1997 – 2008 the annual sport fish harvest of sockeye in the Kvichak River averaged 1,860 fish (Dye and Schwanke 2009)."

Please let us know if you have any other comments or concerns.

Thank You,
Guy

Guy Wade
gwade@lgl.com
Biologist
LGL Alaska Research Associates, Inc.
2000 W. International Airport Rd, Suite C
Anchorage, AK 99502
Phone: 907-562-3339
Fax: 907-562-7223

Response to Agency Correspondence Exhibit C

From: Guy Wade
To: "jordan_muir@fws.gov"
Subject: Igiugig hydrokinetic project Bald Eagle Question
Date: Monday, February 13, 2012 3:04:00 PM
Attachments: Draft Kvichak Fish Monitoring Plan_Dec13.docx

Jordan,
I am working on a project to test a hydrokinetic device on the Kvichak River near Igiugig. I know there are Bald Eagles in the area but I do not believe there is a nest within 201 m of the study site. I base this assumption on:

Interviews with the people who live there,
my experience in the area (4 years as a fishery research biologist) and,
the Bald Eagle nest mapping application Fish and Wildlife provides at:
http://164.159.151.40/private/alaskabaldeagles/viewer.htm.

I have attached the draft biological assessment, this contains the specifics of the project (i.e., exact location, time of project, ect…). This report is in draft form, we will have a final report out at the end this week (Feb 13-17). In the final version we plan to add a section to our monitoring plan that will include Bald Eagle sightings and how to report them. If you are around sometime this week it would be helpful to get your feedback on this subject. I understand you are busy so if this time frame does not allow for comments we will make sure you get a copy of the BA for review.

Feel free to contact me any time,

Thank You,
Guy

Guy Wade
gwade@lgl.com
Biologist
LGL Alaska Research Associates, Inc.
2000 W. International Airport Rd, Suite C
Anchorage, AK 99502
Phone: 907-562-3339
Fax: 907-562-7223

From: Guy Wade
To: "West, Fred (DFG)"
Subject: Commements on Igiugig RISEC project
Date: Thursday, February 16, 2012 11:22:00 AM

Fred,
Thank you for your comments. I will add them to the regulatory agency comments in the monitoring plan.
Guy

Guy Wade
gwade@lgl.com
Biologist
LGL Alaska Research Associates, Inc.
2000 W. International Airport Rd, Suite C
Anchorage, AK 99502
Phone: 907-562-3339
Fax: 907-562-7223

From: West, Fred (DFG) [mailto:fred.west@alaska.gov]
Sent: Wednesday, February 08, 2012 1:51 PM
To: Guy Wade
Subject:

Here you go…
Fred West

Assistant Area Research Biologist
Division of Commercial Fisheries
Bristol Bay Salmon
fred.west@alaska.gov
(907)267-2237

From: Guy Wade
To: "Susan Walker"
Cc: Eric Rothwell; "wprice@ak.net"
Subject: RE: Igiugig RISEC Project No. 13511 Consultation Meeting Minutes
Date: Thursday, February 16, 2012 1:53:00 PM

Sue,
Thank you for taking time to provide comments on the Igiugig RISEC project. It is our plan to incorporate your comments into the final BA and monitoring plan so that these data gaps will be covered. Once the final report is completed it will be submitted for review.

Thanks again,
Guy

cc
Bill Price (AEE)
Bryan Nass (LGL)

Guy Wade
gwade@lgl.com
Biologist
LGL Alaska Research Associates, Inc.
2000 W. International Airport Rd, Suite C
Anchorage, AK 99502
Phone: 907-562-3339
Fax: 907-562-7223

Response to Agency Correspondence Exhibit D

From: Guy Wade
To: "Susan Walker"
Cc: Eric Rothwell; "Bill Price"; "Bryan Nass"
Subject: Reply to Susan Walker"s comment regarding Kvicak River RISEC project
Date: Monday, April 02, 2012 3:15:00 PM

Sue,
Thanks again for taking time to review our project and provide comments. Based on your comments we have made several modifications to our biological assessment and monitoring plan. In this email we have addressed each comment and the BA / monitoring plan will reflect this.

1) - Provide a summary of existing environmental studies, specifically ones directed towards device impacts on fish and fish habitat. Even if these studies are not conducted on Alaskan species there may be relevant information useful for assessing likely project effects and developing conservation recommendations.

RESPONSE: In the BA we have provided a short summary of what has been written in regards to hydrokinetics along with a table that outlines the subject matter of each report. All reports have been added to the literature cited an will be made available to all stakeholders.

2a) - The footprint of each device during different flows and times of the year should be compared to the timing of species and life-stage of fish present. Specifically we are concerned about the footprint of these individual devices during lower flow periods, it will be useful to compare the footprint as compared to the total water column and compared to the cross-sectional area of the channel at the operation flow range.

2b) - Provide a summary table of the cross-sectional use of the project area used for fish migration by species and lifestage. Information was provided during the meeting that implied which parts of the channel adult and juvenile sockeye and Chinook used but this will be useful to see in comparison to the footprint of each device at the flows likely to be encountered.

RESPONSE: In the report we addressed both of these suggestions with a schematic that has been developed to illustrate the foot print of the hydrokinetic devices in a cross section of the proposed area of deployment on the Kvichak River. It should be noted that the stage height and river width fluctuations do not dramatically change the device footprint. Mean annual discharge for the Kvichak River collected near Igiugig from 1968 to 1986 ranged from 361 m3/s to 729 m3/s and averaged 503 m3/s (USGS 2012). During the same time frame monthly discharge has averaged 725 m3/s during August, September, and October; and 327 m3/s during March, April, and May. Based on measurements recorded during similar flows the stage height will vary between 5.6 m (at 318 m3/s) and 6.5 m (at 730 m3/s).

USGS. 2012. National Water Information System: Web Interface, 15300500. Retrieved on February 20, 2012 from the United States Geological Survey webpage: http://waterdata.usgs.gov/ak/nwis/nwismap/?site_no=15300500&agency_cd=USGS.

3) - Avoid placing or operating in-river turbine devices during the important sockeye smolt outmigration period that occurs just after ice-out in May. FERC's pilot licensing process is intended for use in non-sensitive areas. NMFS considers this site during the sockeye smolt outmigration period to be an especially important and sensitive site, as is the adult migration to spawning habitat in and above the lake. Until more data are gathered regarding the possible direct and indirect effects of the devices we recommend avoiding this period when ADF&G records document that as many as 15 million sockeye smolt migrate through this section of river in a single day.

RESPONSE: If there is a deployment of a device in 2012 it will occur after annual outmigration of sockeye salmon smolt. Based on smolt studies conducted on the Kvichak River the outmigration typically last 2-3 weeks and occurs in late May and early June (Wade et al. 2010a, b, 2011, Crawford and West 2001, Crawford and Fair 2003).

4) - In addition, a fisheries monitoring plan of direct and indirect device interactions with adult sockeye and other salmonids of all life-stages should be developed

RESPONSE: A complete monitoring plan has been developed and will be provided along with the biological assessment.

5) - Lake Illiamna supports a unique freshwater population of harbor seals. Data provided by AEA to NMFS indicates that seals do not use the Kvichak River, but are found in the island areas in the north east portion of the lake, and that the seals are year-round residents. NMFS advises that a monitoring plan be developed to ensure that seals do not move through the project site and are not attracted to the tidal turbines or otherwise adversely affected.

RESPONSE: Lake Iliamna is home to one of the two known harbor seal (*Phoca vitulina*) populations that reside in freshwater lakes year-round (Hauser et al. 2008). Since 1991 there have been a number of aerial surveys to estimate the population of these seals, the estimates range from 105 in 2005 (National Marine Mammal Laboratory unpublished) to 321 in 1998 (Small et al. 2001). Distribution is concentrated near the islands located in the northeastern portion of the lake (Withrow and Yano 2009). Although there are no barriers to prevent the seals from leaving the lake there has been no indication that seals move up or down the river (Mathisen and Kline 1992). According to Hauser, the seals feed predominately on spawning sockeye salmon during the summer and smaller resident fishes during the remainder of the year. Although much of the monitoring will focus on fish/device interactions there remains the possibility other wildlife within the ZOI. In the event of a beluga whale or harbor seal sighting a Marine Mammal sighting form must be completed.

Thank You,
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