Yukon River Inter-Tribal Watershed Council

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Attention Robert Piorkowski Ph D. Fish Resource Permit Program Coordinator

This Report is for Permit # SF2009-160
Location: Yukon River near Ruby, AK
Species collected: Local Species

## Abstract:

In late July and early August 2009, the Yukon River Inter-Tribal Watershed Council's 5kW hydrokinetic turbine was deployed on the Yukon River near the village of Ruby Alaska. As part of this project Fish Sampling was conducted by Ed Sarten, environmental technician from Ruby, Alaska and Robert DuBey, fish biologist from the Yukon River Fisheries Drainage Association (YRFDA). The AK Department of Fish and Game (ADFG) biologist for this area, was notified on July 20th, before sampling commenced. Sampling was conducted periodically between July 25th and August 4th 2009. During that time the turbine's rotor was submerged in the water and the turbine was producing power. Due to power transmission problems between the turbine and the shore-based grid connection, the turbine rotor was pulled from the water on August 6th and fish sampling ceased.

## Background:

A hydrokinetic turbine is a method of producing power from running water without the use of dams or water diversion systems. The study at Ruby was conducted using an en-current turbine designed by New Energy LLC, with a generating capacity of 5kW of electrical power. The turbine resembles an upside-down vertical-axis wind turbine suspended below the surface of the river from a pontoon-boat-barge. The barge is tethered to a debris diversion device on the upstream side. The debris diversion device is then anchored to the river bottom via steel cables.

Because the power generated by this system increases exponentially with increases in the river's current velocity, an area of 2.5-3 m/s is ideal for the turbine location. Since the Yukon River freezes during the winter months the turbine must be removed before freeze-up - late September - and redeployed after spring break-up - early June. In 2009 the turbine was deployed on July 25th 2009 and the turbine rotor was pulled from the water on Aug 6th 2009. The barge stayed in the river until September 26th 2009 with the turbine raised.

Smolt disturbance from turbine rotation was predicted to be relatively low because of the slow rotation speed of the rotor (30-70 rpm) and the turbine's relatively small footprint in relation to the width of the river at Ruby. An Acoustic Dopler Profiler (ADP), which takes an image of current velocity across a transect of river was deployed at the Ruby site in late June of 2009. The images from this device reveal a wide distribution of high velocity currents across the ~900m transect.

At Ruby, adult fish common to the Yukon River , include but are not limited to Chinook, Chum and Coho Salmon, Northern Pike, Grayling, Dolly Varden, Whitefish and Sheefish. It is not expected that adult species will be affected by the turbine's rotor because of their aversion to areas of high current velocity and pressure changes such as those caused by the turbine.

The fish study was designed by YRDFA biologist Robert Dubey to detect the presence of both adult and juvenile fish. A multiple beam sonar unit with its transducer mounted upstream of the turbine was used to detect the presence of adult fish around the study site. It was believed the sonar would also have detected juvenile fish migrating in schools. A 1/2"' fyke net positioned downstream of the turbine was intended to catch any juvenile fish that made it through the rotating blades then use these fish to help determine the turbines effect.

Smolt moving downstream were the main targeted concern for this study.

Turbine Location:

The turbine's location was approximately 150 meters off the south bank of the Yukon R. ~350 meters downstream from the village barge dock. The GPS location of the turbine was 64.74109 N Latitude and 155.51156 W. Longitude, determined using the NAD 27 datum. Depth at the site of deployment was 11-13m. The two concrete blocks used as anchors are located south of the thalwag where the riverbed begins to slope up towards the south bank. The current velocity at the turbine site was ~1.5-1.8 m/sec. It is important to note this was NOT the site of fastest current velocity as identified by the ADP.

Turbine Footprint:

When the turbine is in the water, its rotor extends approximately 2 meters below the river surface into the water column. The rotor has a swept diameter of ~1m. The pontoon barge is tethered downstream of a debris diversion device, which resembles an V with the tip pointed upstream. This diversion device is connected to the anchoring system with steel cable and chain. The power cord is hung from the backside of the barge, straight down to the river bottom then along the riverbed to shore.

**Sampling Procedure:**

Pre-deployment:

On July 10th, 11th 2009, fish finder Sonar was used for preliminary sampling at the turbine site. The sonar was mounted to a skiff, which motored to the turbine site as identified by GPS coordinates and visual points on shore. Sonar was run for 5 minute intervals 2x a day, once in the morning (between 0900-1100) and once in the evening (between 1700-1900). These pre-deployment sonar readings were taken to get a rough estimate of fish abundance in the area of deployment, before the turbine was deployed.

Post-Deployment:

Sampling from the turbine barge began on July 25th 2009. One "sample" consisted of two, 5-minute sampling windows spread over the course of a ½ hr. During this window, a ½-inch mesh fyke net was deployed from the downstream side of the barge and held approx one meter below the surface of the water. The net was periodically pulled up to remove debris - sticks, brush etc. – so that water could move smoothly through it. During the fyke net deployment, the second member of the sampling team monitored the fish finder sonar - positioned at the front of the barge, upstream of the turbine. Once a 5 minute sampling window was complete the sampling team would wait for 10-20 minutes on the barge, then repeat the sample with a different person using the fyke net and sonar.

This method was used twice a day from July 25th-July27th . Then once a day on July 29th, July 31st and August 4th.

**Results:**

During the Pre-deployment Sonar sampling on July 10th and 11th, 3 fish were detected by fish finder sonar. All were in the lower half of the water column. Approx 8-13m below the water surface. Based on the sonar image, these were adult fish, but their species could not be determined.

Fish sampling using the methodology discussed above was conducted between the dates of July 25th and August 4th 2009. During this time, no fish were caught in the fyke net and the sonar detected no fish. In total 9 full samples – consisting of 2-sampling windows each – were taken by field technicians from the Ruby turbine barge.

**Discussion:**

The lack of fish detected or caught during our sampling suggests that their concentrations in our turbine's area of the river are relatively low. Local fishermen from Ruby AK typically fish with fish wheels set in areas of lower current velocity near the river banks. Francis Captain, a resident of Ruby and subsistence fisherman reported catching King Salmon, Coho Salmon, Suckers, Whitefish and a variety of other freshwater species in his

fish wheel ~1.5 miles downstream of Ruby on the Yukon. This proves the presence of these species in the near shore areas on this section of the Yukon.

Our ADP revealed a steady rise from the Thalwag to the south bank of the river, which ends in steep, cliffs just downstream of Ruby village. By contrast, the riverbed to the north of the Thalwag rises at a gradual rate. Current velocity in the north half of the river is also shown to be weaker than in the southern half (see ADP image included at the end of this report). This could suggest that fish species are more likely to hug the north bank of the Yukon as they pass Ruby.

**Possible Errors and Improvements:**

The timing of Smolt runs can be difficult to predict but many biologists believe they occur in the first half of the summer, June-mid July. Due to the delayed deployment of our turbine, sampling did not begin until July 25th. At this point, the sampling may have missed the majority of the Smolt run. The sonar used in ruby, produced images that were possibly too blurry to detect the presence of Smolt, unless they were moving in schools.

The turbine's location in swift current made getting on and off the barge a somewhat hazardous task. Due to safety concerns, limitations on the reliability of field technicians in Ruby and initial results which showed no fish, the decision was made to reduce our initial sampling schedule and make less frequent trips to the barge.

If you have any questions in regards to the results or aspects of the fish study preformed in Ruby, please contact me directly. It should be noted that between the time this permit was requested and the time this report was submitted, 4 project managers have come and gone from the project and information transfer has been difficult.

Sincerely,

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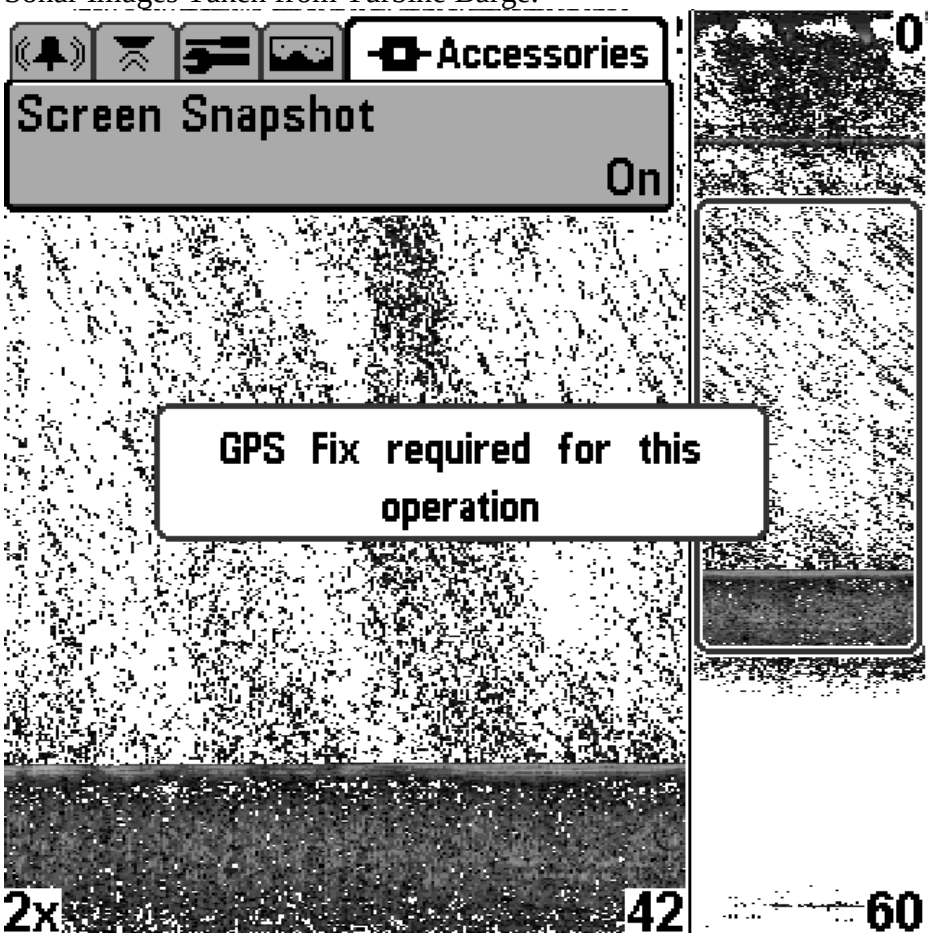
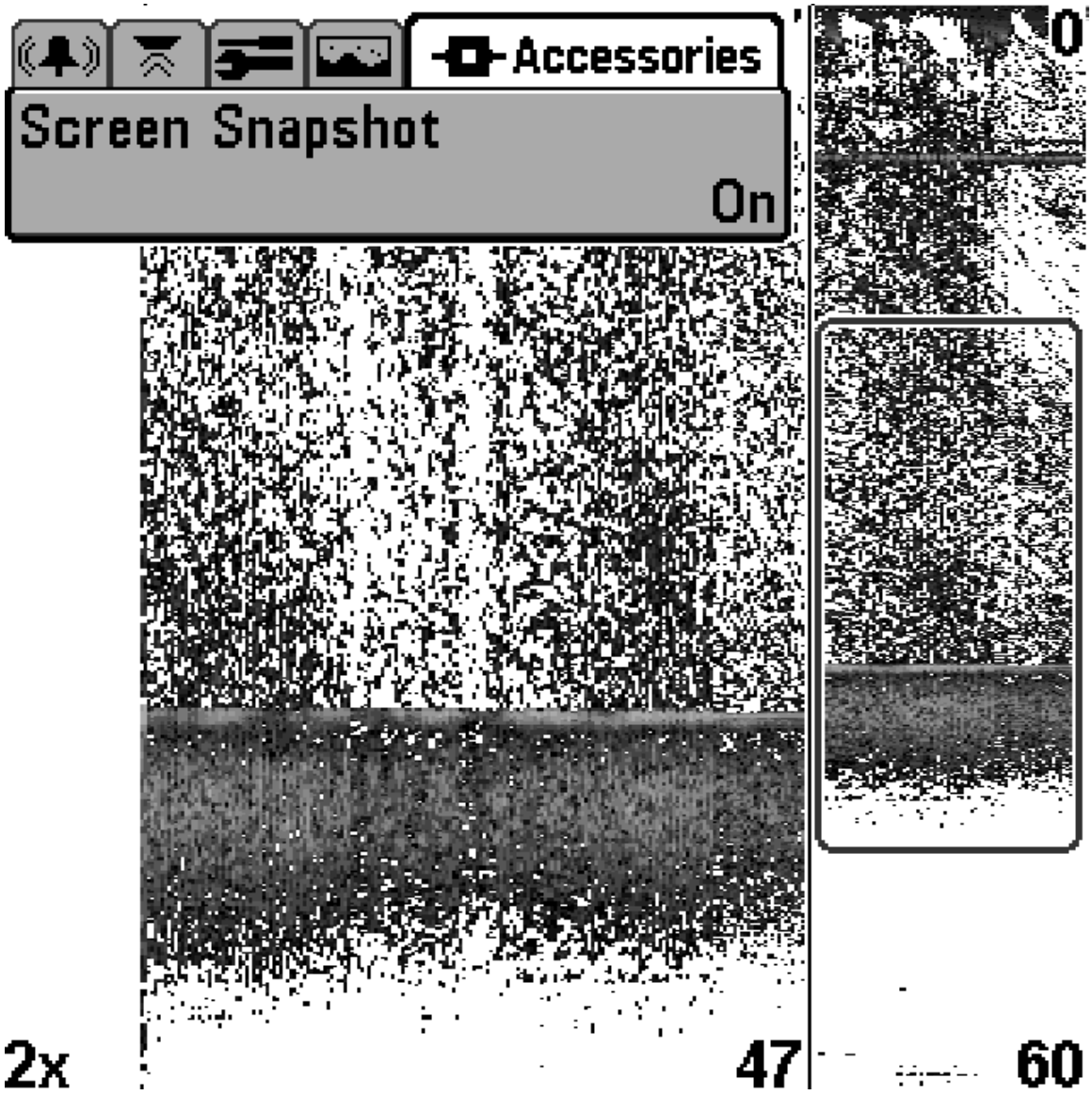
Samples Taken at Turbine Site:

| Date: | Time of sample: | # Fish caugh in Fyke Net ~1m below surface | # of Fish detected in sonar: | Technicians: | GPS Pts. |
|---|---|---|---|---|---|
| July 10, 2009 | 0900 | N/A | 0 | Martin Leonard<br>Ed Sarten | 64.741 N<br>155.511 W |
| July 10, 2009 | 1740 | N/A | 1 | Martin Leonard<br>Ed Sarten | 64.741 N<br>155.511 W |
| July 11, 2009 | 1000 | N/A | 2 | Ed Sarten<br>Emit Peters | 64.741 N<br>155.511 W |
| July 11, 2009 | 1820 | N/A | 0 | Martin Leonard<br>Emit Peters | 64.741 N<br>155.511 W |
| July 25, 2009 | 1010-1040 | 0 | 0 | Ed Sarten<br>Emit Peters | 64.741 N<br>155.511 W |
| July 25, 2009 | 1730-1800 | 0 | 0 | Ed Sarten<br>Emit Peters | 64.741 N<br>155.511 W |
| July 26, 2009 | 0930-1010 | 0 | 0 | Ed Sarten<br>Emit Peters | 64.741 N<br>155.511 W |
| July 26, 2009 | 1800-1900 | 0 | 0 | Ed Sarten<br>Emit Peters | 64.741 N<br>155.511 W |
| July 27, 2009 | 1030-1100 | 0 | 0 | Ed Sarten<br>Emit Peters | 64.741 N<br>155.511 W |
| July 27, 2009 | 1700-1740 | 0 | 0 | Ed Sarten<br>Emit Peters | 64.741 N<br>155.511 W |
| July 29, 2009 | 1500-1540 | 0 | 0 | Ed Sarten<br>Emit Peters | 64.741 N<br>155.511 W |
| July 31 2009 | 1900-1920 | 0 | 0 | Ed Sarten<br>Emit Peters | 64.741 N<br>155.511 W |
| Aug 4, 2009 | 1100-1130 | 0 | 0 | Ed Sarten<br>Emit Peters | 64.741 N<br>155.511 W |
| | | | | | |

Hydrokinetic Turbine in Yukon outside of Ruby, AK

Sonar Images Taken from Turbine Barge:

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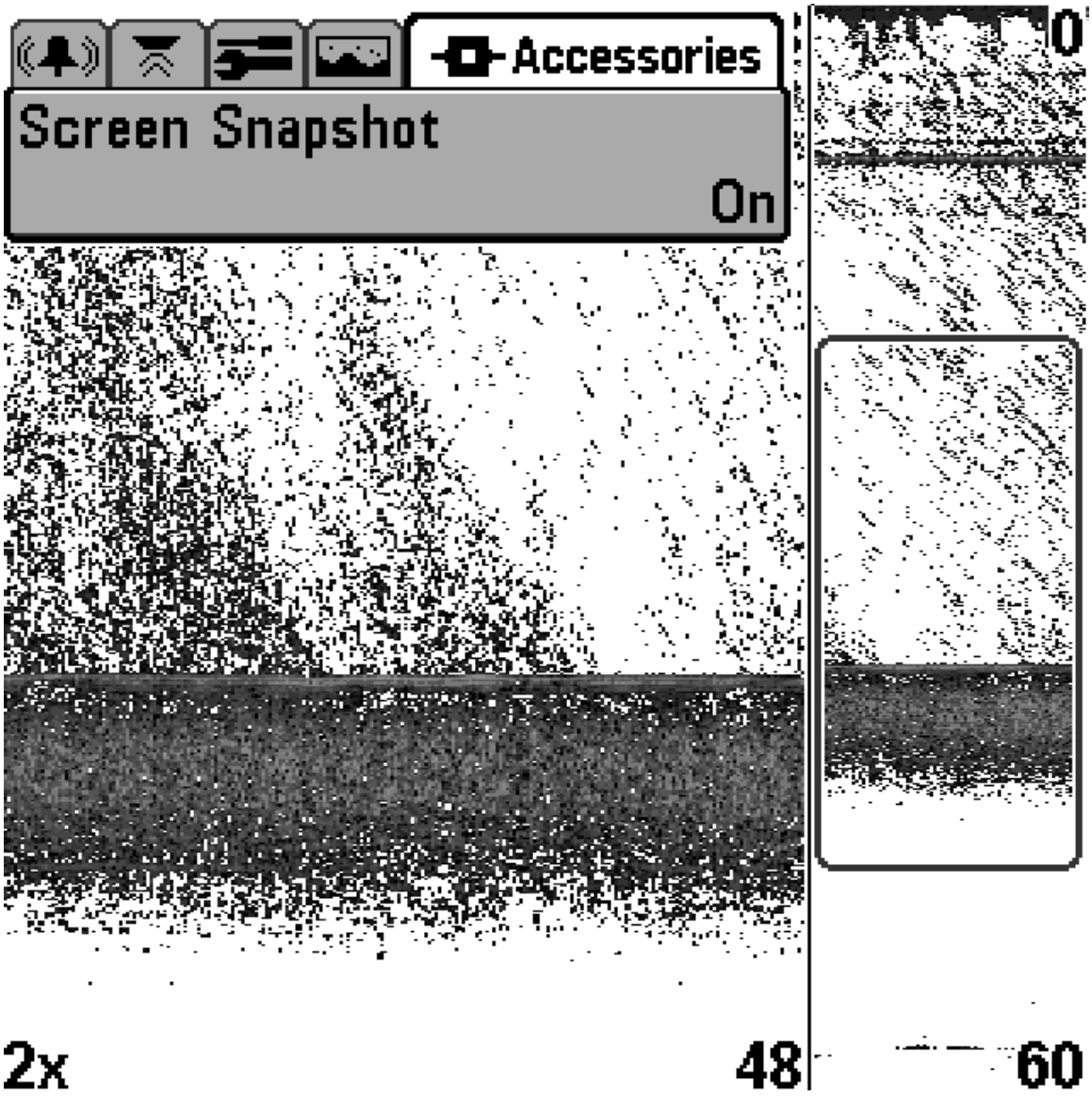
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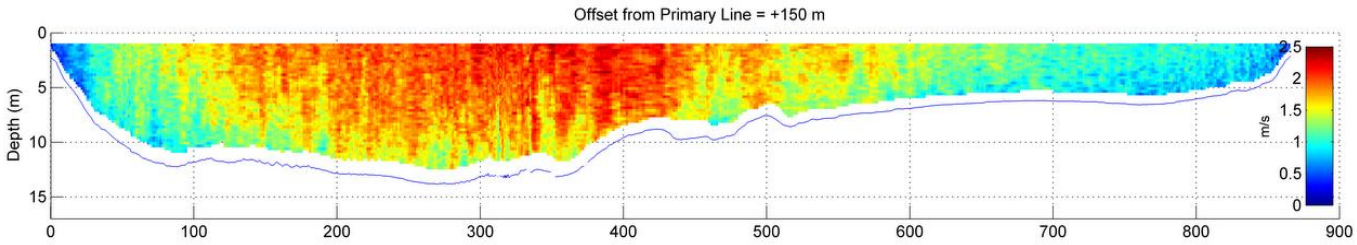


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X

The above image represents a transect of the River where our turbine was placed. The X above indicates the approximate position of the turbine in an area of current ranging between 1.5-2 m/s as shown by the color coded scale at the Right side of the image. As you can see this is not the fastest current along the transect.

Transect of Yukon River just downstream of Ruby, AK. “X” in this picture marks the approximate location of the turbine. The image shows an outline of the River Thalwag (the deepest points are dark blue and purple, the shallowest areas are red). The Ruby barge dock is barely visible at the bottom R. corner of the screen.