U.S. Fish and Wildlife Service
Office of Subsistence Management
Fisheries Resource Monitoring Program

Indexing the inseason abundance of salmon in the lower reaches of the Copper River Delta, 2005 Annual Report

Annual Report No. FIS 04-506

Native Village of Eyak

Aquacoustics, Inc.

ALASKA DEPARTMENT OF FISH AND GAME

LGL
Alaska Research Associates, Inc.

February 2006

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February 2006

Annual Report Summary Page

Title: Indexing the inseason abundance of salmon in the lower reaches of the Copper River Delta, 2005 Annual Report

Study Number: 04-506

Investigators/Affiliations: Bruce Cain and Keith van den Broek/Native Village of Eyak; Anna-Maria Mueller and Don Degan/Aquacoustics, Inc.; Steve Moffitt/Alaska Department of Fish and Game, Commercial Fisheries Division; Michael Link and Jason Smith/LGL Alaska Research Associates, Inc.

Management Regions: Cook Inlet/Gulf of Alaska

Information types: Stock Status Trends, Fisheries Monitoring

Issues Addressed: Improve inseason escapement indices of salmon in the lower Copper River, downstream of the Miles Lake sonar site.

Study Cost: $193,059 (three-year total)

Study Duration: March 2004 – February 2007

Key Words: Copper River, inseason management, sockeye salmon, *Oncorhynchus nerka*, Chinook salmon, *Oncorhynchus tshawytscha*, subsistence fishery, drift gillnet, acoustics, Native Village of Eyak.

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EXECUTIVE SUMMARY

The purpose of this three-year project (2004-2007) is to generate a daily inseason index of early run salmon abundance in the lower Copper River, and to estimate the travel time of salmon from the commercial fishing area (Copper River District) to the test fishery at Flag Point Channel and the Miles Lake sonar site. This will provide Alaska Department of Fish and Game (ADF&G) fisheries managers with more timely escapement information than is currently available from the Miles Lake sonar site alone. The project builds on the results of a study conducted in the previous three years (2001-2004), which compared the utility of acoustics and drift gillnets as test fishing tools, developed a cost-effective method for acoustic sampling, and provided insights into fish migratory behavior in the study area.

In 2005, acoustic sampling at Flag Point Channel started on 5 May, one week before the Miles Lake sonar site was fully operational and 11 days before the first commercial fishing period. Acoustic sampling continued until 29 May 2005. Apart from minor disruptions, sampling was essentially continuous. Visual echo trace counts were generated from the echogram during the first 15 minutes of each hour. As in previous years, salmon echo traces were easily distinguished from eulachon. Daily counts, calculated by summing and expanding 15-minute counts, totaled 9,022 salmon for the period sampled, with a peak of 992 fish on 21 May. Counts up to 0700 hours of the current day were reported to ADF&G daily by 0900 hours.

As in previous years other than 2003, acoustic counts of salmon for Flag Point Channel provided a presence/absence index of salmon abundance. The counts also tracked the general trends in salmon abundance observed at the Miles Lake sonar site. The catch efficiency at Flag Point Channel started at 100 fish and declined to 50 fish per 1,000 fish counted at Miles Lake. Similar to previous years, estimated travel time ranged from 1 – 3 days between the sampling site at Flag Point Channel and Miles Lake (approximately 30 km distance) and 1 – 2 days between the Copper River ocean fishing district and Flag Point Channel (approximately 20 km distance).

INTRODUCTION

This project addresses subsistence fisheries-monitoring issues for Copper River sockeye *Oncorhynchus nerka* and Chinook *O. tshawytscha* salmon, as outlined under Stock Status and Trends by the Federal Subsistence Regional Advisory Council in the Fall of 2002 (OSM 2002). It addresses the need for annual collection and reporting of salmon stock assessment for stocks that support important federal subsistence fisheries. The main goal of this project is to index the abundance of salmon in the lower Copper River, and to provide fishery managers with timelier inseason information than is currently available from the Miles Lake sonar site. The lower river index is not intended to replace or duplicate the existing Miles Lake sonar site. Instead, its purpose is to provide a more timely index of salmon abundance that fishery managers can use in conjunction with the more precise but delayed information from Miles Lake to better manage the commercial fishery and ensure that an adequate number of fish make it upriver for subsistence harvests and spawning requirements.

The three-year pilot study (2001–2003) also compared the relative strengths and weaknesses of acoustics and drift gillnetting to identify which technique would be the better choice for continued use on the lower Copper River (Degan et al. 2004). The authors concluded to discontinue drift gillnetting and use acoustics to index salmon abundance at Flag Point Channel. This conclusion was largely based on the substantially higher sampling power of acoustics and its ability to differentiate up- and downstream migration.

This project builds on the results and experience gained in the three-year pilot study. Project objectives were to:

1. Generate a daily inseason index of early run salmon abundance in the lower Copper River to provide ADF&G managers with more timely escapement information than is available from the Miles Lake sonar site; and

2. Estimate the travel time of salmon from the commercial fishing area (Copper River District) to both the test fishery at Flag Point Channel and the Miles Lake sonar site.

STUDY AREA

The Copper River flows through the Chugach Mountains of Alaska and drains into the northern limits of the Gulf of Alaska, east of Prince William Sound (Figure 1). The lower river sample site is located in the Flag Point Channel, 400 m downstream of Bridge 331 of the Copper River Highway (Figure 2). This site is approximately 30 river kilometers downstream of the Miles Lake Sonar Station, and 20 river kilometers upstream of the Cordova Commercial Fishing District. In April 2005, while low water exposed much of the sampling area, the site was again inspected. No major changes were found. The gradient of the site was still smooth and uniform but compared to previous years, there was less debris embedded immediately upstream. The site appeared again suitable for acoustic sampling and no new bathymetry survey was conducted.

METHODS

River stage height and weather information were recorded on most sampling days. Stage height was measured at a U.S. Geological Survey (USGS) gauge mounted on Bridge 331 and provided a relative measure of river elevation (the elevation of the bridge above sea level was not known). Stage height data were also obtained from a USGS gauge mounted on Million Dollar Bridge located at the outlet of Miles Lake. Weather information collected each day included cloud cover, precipitation, wind velocity (km/h), and wind direction.

The acoustic system and methods used in 2005 was the same system used in 2004 (Mueller and Degan, 2005). The transducer was deployed nearshore on the river bottom and aimed offshore, perpendicular to the river current, with the wide axis of the beam horizontal and the narrow axis vertical. The design of the transducer mount allowed adjustments in the vertical position and tilt angle of the acoustic beam. An analog tiltmeter (+/- 10° angular range, 0.5° resolution) was attached to the mount, such that its tilt was aligned with the transducer. This tiltmeter, which provided a direct read of the transducer tilt angle, allowed easy and controlled adjustment of the transducer on site without requiring access to computer data. A float switch was installed to automatically turn off the echosounder when the transducer becomes exposed to air, thereby preventing damage to its ceramic elements.

The operational setup of the camp was different in 2005. Rather than a streamside and trailer side setup connected by a wireless bridge, the entire facility was consolidated onto the streamside. This location was the same as was used in the previous three years (Mueller and Degan, 2005). A weatherproof aluminum box housed the echosounder, power supply, Starband modem, and a laptop computer (Gateway SOLO, Pentium II, Linux) with 250 GB external hard drive. Technicians resided in a large tent on a plywood platform, which also housed a desk and laptop computer (Dell D600, 512 MB RAM, 1.2 GHz Processor, 40 GB Storage, Windows XP). The laptop computer in the box was programmed to automatically subsample and upload relevant echogram files to a remote ftp server, while the computer in the tent was used by technicians for data analysis and to access email to send daily updates. The power supply consisted of a 12-V battery bank with a capacity of 700 amp hours, charged through an 3000-W inverter/charger by two 75-W solar panels and a 5-kW generator. The Starband connection was used mainly for data transfer to NVE in Cordova and Aquacoustics personnel who checked the counts and the quality of the acoustic data and provided technical support to the on-site crew. Email was the primary means of communication. A satellite phone and VHF radio were available for emergencies.

To sample migrating salmon, the transducer was aimed along the river bottom. The aim of the transducer was verified using a plastic sphere (10-cm diameter) with target strength similar to an adult salmon. The sphere was lowered in front of the transducer using a fishing rod, raised 15 cm off the river bottom and then moved in- and offshore as much as water depth and current allowed. The aim of the transducer was confirmed when the target echoes were clearly visible and strong enough to qualify as salmon at least every 0.5 m. Fish were sampled with a transmit power of 200 W, ping rate of 14 pings per second, and a pulse length of 0.256 milliseconds.

A weir made from rebar and construction fencing was installed approximately 1 m downstream of the transducer and extended into the river about 1 – 2 m past the transducer. The weir kept fish from passing close to the transducer where the acoustic beam is not coherently formed or too small to efficiently detect fish. The weir had to be close to the transducer to prevent fish from coming back inshore before having passed the transducer. In addition, several pieces of rebar were put in about 20 m upstream of the transducer to direct ice floes offshore and away from the transducer. Unlike the weir, the ice deflection bars had to be at least 15 m upstream of the transducer to prevent the acoustic noise created downstream of an obstacle from interfering with the sonar beam. The position of the ice deflection bars also took advantage of the natural pattern of the river current, which, at that location, hit and was deflected off the riverbank at a relatively steep angle. Technicians regularly removed debris from the weir and the transducer mount and wiped algae growth off the transducer face.

Counts were done for the first 15 minutes of each hour using the same methodology as in 2004 (Mueller and Degan, 2005). Daily counts were generated by summing and expanding the 15-minute counts to hourly counts by multiplying by 4. When data collection was interrupted, counts were expanded for missing hours by taking the interpolation between the last good hour before the data gap and the first good hour after the gap.

RESULTS

Stage height of the Copper River was recorded at the Flag Point Channel East and West Bridge beginning May 12 and at the Million Dollar Bridge starting 10 May (Table 1). Throughout the sampling period, stage height was above 2.5 m at the Flag Point Channel and, with the exception of 11 May, above 40 m at the Million Dollar Bridge.

The acoustic system was operated at Flag Point Channel for a total of 567 h (98% of the time) from 0800 hours on 5 May to 0700 hours on 29 May 2005. Counts were interrupted for a total of 11 h during the season.

A transducer pitch of -3.5 to -4° was maintained throughout the sampling period, yielding a counting range of 20 m.

Visual review of target strength echograms showed very good separation of eulachon (*Thaleichthys pacificus*) and salmon. Displaying the echograms at very low thresholds (-65 dB and lower) revealed eulachon tracks but these were easily discerned from the much stronger tracks left by salmon. Angle echograms indicated little to no downstream movement of salmon.

Daily counts totaled 9,022 salmon for the period sampled (5 - 29 May), with a peak of 992 fish on 21 May. It took the field technicians approximately 2 h to count a 24-h period. NVE and Aquacoustics staff checked a subsample of at least four 15-minute counts per day and provided feedback to the technicians within 24 hours. Validated counts were forwarded to NVE and ADF&G by 0900 hours each day.

Similar to 2001, 2002 and 2004, relative changes in acoustic counts at Flag Point Channel mirrored the trends in the counts generated by the Miles Lake sonar. The comparison of time series plots of acoustic counts with Miles Lake data lagged 1-day lag provided the best alignment of peaks and slopes of the Flag Point Channel and Miles Lake counts. This alignment appears to stretch closer to a 2-day lag towards the final 2 days of the study period, which correlates with rising water levels (Figure 3). Further inspection of the time series using a 1-day lag suggested a distinct change in the ratio between the Flag Point Channel and Miles Lake counts. The ratio dropped from 10:1 prior to 21 May to 25:1 after May 23. May 22, the ratio was midway between the two periods.

The 3-day moving average of the Flag Point Channel acoustics catch efficiency (Flag Point Channel index per 1,000 fish counted at Miles Lake) was compared to data from 2002 and 2004 (Figure 4). The efficiency of the Flag Point Channel started lower in 2005 than in 2002 and 2004, but ended at a similar ratio to the other 2 years. In 2002 and 2005, a 1-day lag was applied to the Miles Lake data (considered to give the best fit), whereas a 2-day lag was used in 2004. Data from 2003 were not included in the comparison because Flag Point Channel acoustic data were poor due to the extremely low water level (Link et al. 2001; Lambert et al. 2003).

In 2005, as in the previous four years, daily acoustic indices at Flag Point Channel decreased 1-2 days after the start of each commercial fishing opening in the Copper River District, suggesting that salmon migrated from the fishery to Flag Point Channel in about 1-2 days (Figure 3).

DISCUSSION

No problems were encountered with the Simrad ER60 data acquisition software or the EK60 echosounder system throughout the sampling period. Once installed, the Starband system also performed very well. The data upload was automated to expedite quality control of the acoustic data. Installing a second computer on the network to upload the data through the Starband system allowed the data collection and analysis computer to operate smoothly throughout the year.

As in 2001, 2002 and 2004, acoustic sampling conditions at Flag Point Channel were very good in 2005. Consistent display settings and the high quality of acoustic data made it easy to distinguish salmon from eulachon tracks. Having no threshold applied to data collection meant that data could also be viewed at lower display thresholds than in the past, which sometimes helped in the interpretation of the data. Review of angle color echograms indicated that very few salmon were moving downstream.

The total number of salmon counted, the good separation of salmon and eulachon, and fish behavior were comparable to the first two years of the pilot study, and the first year of the current study. After the difficulties experienced in 2003, there was concern that the low-water conditions in Flag Point Channel were related to the Copper River shifting towards its eastern channels to an extent that would make Flag Point Channel unsuitable for sampling. Results from 2004 and again in 2005 indicated that, for the time being, Flag Point Channel is still suitable for

acoustic sampling. The highly dynamic delta remains, of course, unpredictable and the site will need to be reassessed every year before sampling.

Fishery managers recognize two broad but useful levels of precision for "indexing" in-river escapement from the commercial fishery in the Copper River District: presence/absence and a more quantitative measure such as: more than a few hundred fish, less than 20,000 fish, etc. Each year, in the earliest stages of the salmon run (mid-May), managers simply want to know whether or not there are fish present in the river upstream of the commercial fishery. This is sometimes enough information to influence management decisions. In 2005, as in every year since its inception, with the exception of 2003, the Lower River Test Fishery accomplished the goal of determining when fish first entered the river in significant numbers.

However, it has also become clear that the number of salmon sampled at Flag Point Channel does not represent a fixed percentage of the number of salmon counted at the Miles Lake sonar site. This is not surprising since Flag Point Channel is only one of several alternative migration routes, and we sampled just one side of the channel. Nevertheless, as long as there is a systematic component in how the percentage sampled at Flag Point Channel varies, it will still be possible to establish an index that is more precise than mere presence or absence. The trend observed in 2005 is consistent with the data from 2002 and 2004, with the exception that the catch efficiency in 2002 and 2004 started at more than 20% while in 2005 the efficiency started at 10%, then gradually declining, and leveling out at around 5% all 3 years. Only data collected over additional years will tell how consistent this pattern is from year to year and how precise the index will be in the medium to long term. The decline in the relative number of fish sampled at Flag Point Channel is consistent with the sequence in which the channels of the Copper River Delta break up in spring and reports from local fishermen who observed that, early in the run, salmon tend to aggregate (and presumably enter the river) on the west side of the delta and only later shift towards the east. Channels in the vicinity of Flag Point are among the first channels to become ice-free. Early fish may therefore be more likely to migrate through Flag Point Channel than fish entering later when more alternative routes become available.

The systematic variation in the percentage of fish sampled at Flag Point Channel was also reflected by the general alignment of peaks and troughs in the Flag Point Channel and Miles Lake counts observed throughout the 2005, 2004, 2002, 2001 and in the second half of the 2003 sampling period. Again, this suggests that it may be possible to obtain an index that goes beyond mere presence or absence.

The speed at which fish migrated from Flag Point Channel to Miles Lake (1-3 days for approximately 30 km) was similar to the apparent speed of migration from the commercial fishing district to Flag Point Channel (1-2 days for approximately 20 km). Given the speed of migration, the Flag Point Channel index provided information on the number of fish entering the river that was 1 – 3 days more up-to-date than the Miles Lake sonar counts.

An advantage of the Lower River Test Fishery project arises from the early start-up date. In 2005, acoustic sampling at Flag Point Channel began on 5 May, one week before the Miles Lake sonar site was clear of ice and fully operational and 11 days before the first commercial fishing

period. It is early in the season, when high fish prices add to the pressure on managers to open the commercial fishery, when up-to-date information on whether and how many fish have entered the river is especially important.

CONCLUSIONS

1. The quality of the acoustic data was very good. Salmon were easily distinguished from eulachon. Flag Point Channel remained suitable for sampling.

2. Flag Point Channel counts provided a clear presence/absence type index and mirrored the general trends in the Miles Lake counts. Trends in the catch efficiency over the study period were similar to those observed in 2002 and 2004. If this pattern is consistent in the future then these data may be used for a more quantitative index.

3. The apparent fish migration speed was similar to previous years. Overall, a 1-day lag between Flag Point Channel and Miles Lake produced good match. Fish appeared to take 1 – 2 days to travel from the commercial fishery in the Copper River District to Flag Point Channel.

RECOMMENDATIONS

For 2006, we recommend to:

1. Continue to use acoustics to sample at Flag Point Channel, unless channels change significantly before May 2006; and continue to provide a daily inseason index of abundance;
2. Examine the among-year variability in the ratio between the Flag Point Channel and Miles Lake counts;
3. Examine the among-year variability in fish behavior and migration speed;
4. Continue to improve upon the equipment setup streamlining and power supply improvements made in 2005.
5. Investigate options for a high speed internet link to replace the Starband system. The Cordova Telephone Cooperative has built a repeater tower near the project site, and it may be feasible to provide landline telephone and DSL internet service here.

ACKNOWLEDGMENTS

Special thanks to Jeremy Sofonia, NVE technician and Matthew Opalka ADF&G technician who conducted the acoustic fieldwork and provided inseason counts. Keith van den Broek (NVE) counted for quality control and summarized the data for release, and provided logistical support that was instrumental to the success of this project. Justin Burket provided invaluable assistance with power supply and communications setup. We also thank everyone who attended the public workshop in Cordova and provided valuable feedback on the project.

This project was approved by the Federal Subsistence Board, managed by the U.S. Fish and Wildlife Service, Office of Subsistence Management and funded by the USDA Forest Service (USFS) under contract 53-0109-4-0038. The project was a cooperative effort between the USFS, NVE, Aquacoustics, LGL and ADF&G.

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FIGURES

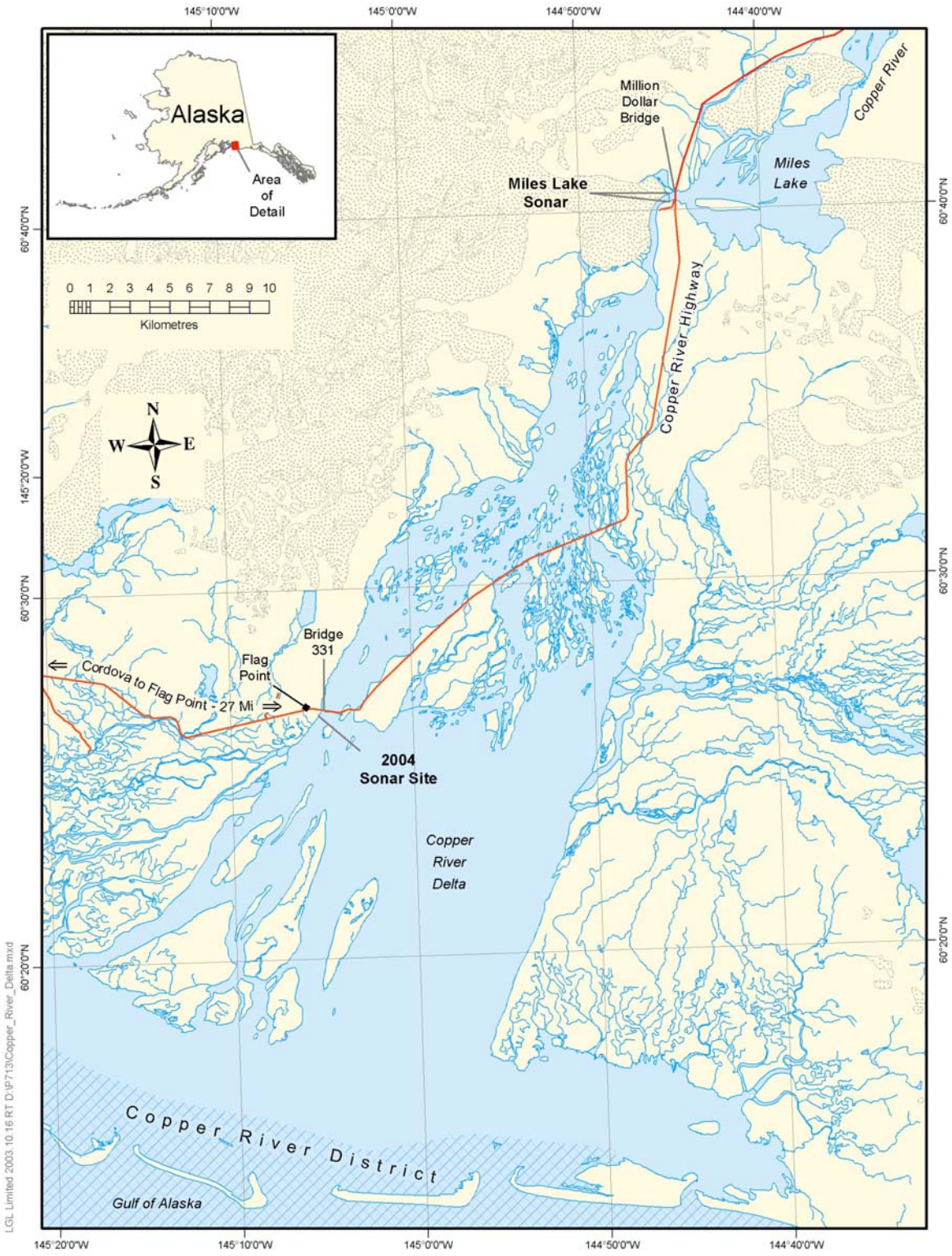

Figure 1. Map of the lower Copper River in Alaska showing the location of Flag Point Channel and the Miles Lake sonar site, 2005.

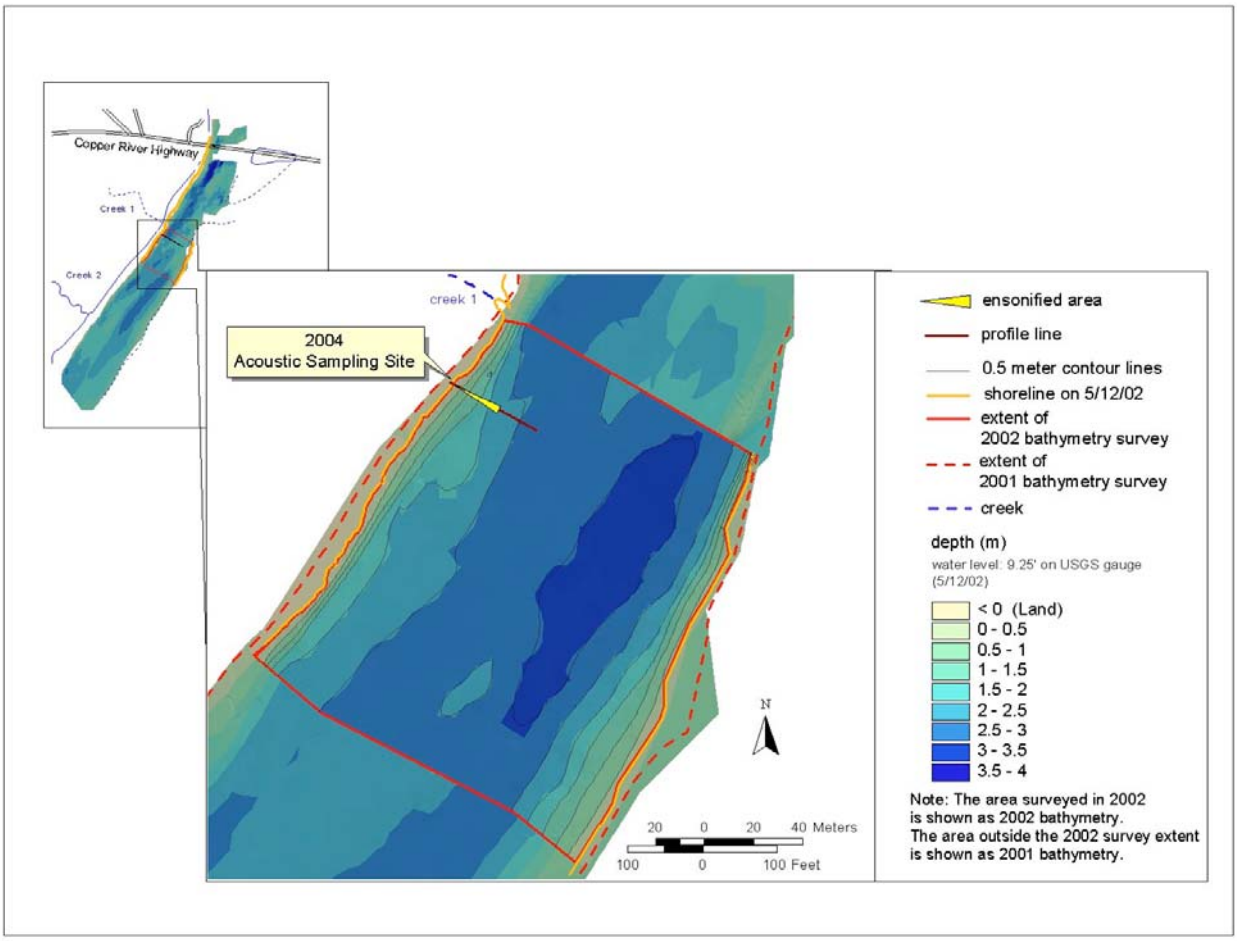

Figure 2. Bathymetry of the Flag Point Channel acoustic sampling site used 2002 through 2005. The site was located 400 m downstream of Bridge 331 on the Copper River Highway.

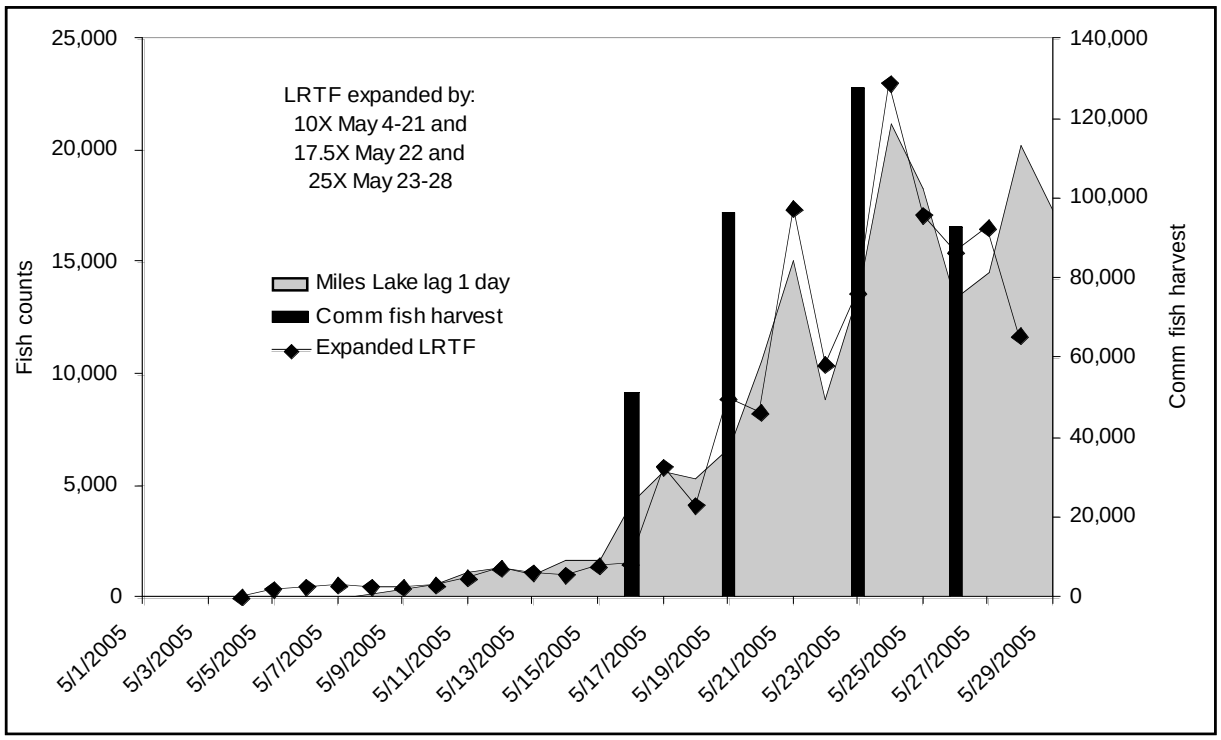

Figure 3. Daily acoustic indices for salmon at Flag Point Channel, sonar counts from Miles Lake and the starting dates of commercial fishing openings in the Copper River District, 2005.

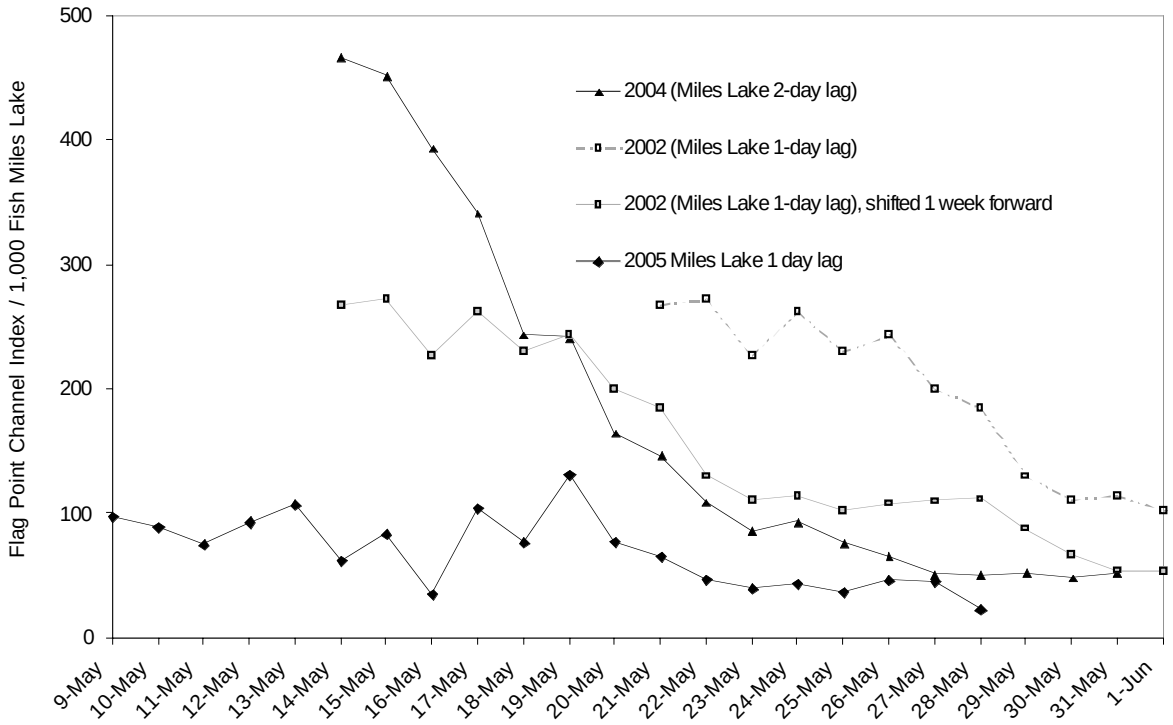

Figure 4. Catch efficiency of Flag Point Channel acoustics, as measured by the ratio of the Flag Point Channel Index to the Miles Lake Sonar count (index per 1,000 fish counted at Miles Lake; 3-day moving average). For 2004 and 2005, data series starts with the day the Miles Lake sonar became fully operational. The 2002 data are shown for comparison, including a data series shifted back 1 week to coincide with the 2004 and 2005 pattern.

TABLES

Table 1. Stage height (m) of the Copper River at Flagg Point Channel and the Million Dollar Bridge, 2005. Stage height was measured using USGS gauges and is a relative measurement as the current bridge elevations above mean sea level are unknown.

	Flag Point Channel		Million Dollar	Weather
Date	West Bridge	East Bridge	Bridge	
10-May			40.05	
11-May			39.77	
12-May	2.54	2.50	40.18	NE wind ~15-25 knots, cloudy with showers
13-May	2.58	2.56	40.41	NE wind ~15-35 or 40 knots, overcast with rain
14-May	2.71	2.78	40.54	overcast, rain on its way
15-May	2.76	2.86	40.66	N wind 5-10 knots, overcast and raining
16-May	2.92	2.83	40.86	partly cloudy, 5-10 knot breeze
17-May	2.60	3.02	41.00	NE 10 knots, overcast and rain
18-May	3.02	2.96	41.11	NE 15-20 knots, Sunny and clear.
19-May	3.00	2.93	41.05	5-10 knots (light),partly cloudy
20-May	3.01	2.92	41.07	N wind 5-10 knots, overcast, light showers
21-May	3.29	3.00	41.13	NE 5-10 knots, overcast with occasional showers
22-May	3.02	3.34	41.18	NE 5 knots, mostly sunny with scattered clouds
23-May	3.10	3.34	41.2	NE 5-10 knots, overcast
24-May	3.21	3.15	41.37	rain
25-May	3.25	3.19	41.41	Overcast with light rain
26-May	3.23	3.30	41.46	NE wind ~15-20 knots overcast w/ rain
27-May	3.26	3.91	41.51	NE wind ~15-20 knots overcast w/ rain
28-May			41.55	
29-May			41.53	
30-May			41.42	
31-May			41.56	
1-Jun			41.57	

Table 2. Daily salmon counts and escapement objectives at the Miles Lake sonar, 2005.

Date	Stage height (m)	Estimated daily escapement				5 Year Average Counts	
		North Bank	South Bank	Daily	Cum.	Daily	Cum.
9-May	0		192	192	192	0	0
10-May	40.05		451	451	643	0	0
11-May	39.77	12	614	626	1,269	0	0
12-May	40.18	256	923	1,179	2,448	0	0
13-May	40.41	240	1,137	1,377	3,825	0	0
14-May	40.54	112	934	1,046	4,871	0	0
15-May	40.66	112	1,561	1,673	6,544	342	342
16-May	40.86	56	1,620	1,676	8,220	422	764
17-May	41	192	4,094	4,286	12,506	520	1,284
18-May	41.11	463	5,145	5,608	18,114	636	1,920
19-May	41.05	396	4,990	5,386	23,500	1,403	3,323
20-May	41.07	552	6,210	6,762	30,262	1,307	4,630
21-May	41.13	992	9,627	10,619	40,881	2,582	7,212
22-May	41.18	1,072	13,997	15,069	55,950	3,693	10,905
23-May	41.2	1,132	7,771	8,903	64,853	6,421	17,326
24-May	41.37	1,296	12,570	13,866	78,719	10,502	27,828
25-May	41.41	2,288	18,881	21,169	99,888	12,635	40,463
26-May	41.46	4,858	13,486	18,344	118,232	10,342	50,805
27-May	41.51	1,656	11,713	13,369	131,601	10,171	60,976
28-May	41.55	1,080	13,472	14,552	146,153	11,857	72,833
29-May	41.53	2,755	17,539	20,294	166,447	17,123	89,956
30-May	41.42	3,664	13,642	17,306	183,753	16,868	106,824
31-May	41.56	1,736	16,250	17,986	201,739	13,739	120,563
1-Jun	41.57	2,304	14,437	16,741	218,480	14,014	134,577
2-Jun	41.57	2,440	11,197	13,637	232,117	14,451	149,028
3-Jun	41.55	1,496	10,006	11,502	243,619	15,146	164,174
4-Jun	41.52	240	8,682	8,922	252,541	12,333	176,507
5-Jun	41.63	1,280	12,720	14,000	266,541	14,260	190,767
6-Jun	41.78	1,248	9,310	10,558	277,099	13,645	204,412
7-Jun	41.84	1,546	10,866	12,412	289,511	12,497	216,909
8-Jun	41.92	2,504	15,060	17,564	307,075	11,762	228,671
9-Jun	41.87	1,368	13,824	15,192	322,267	12,558	241,229
10-Jun	41.88	2,800	10,056	12,856	335,123	11,003	252,232
11-Jun	42.03	2,768	15,252	18,020	353,143	12,116	264,348
12-Jun	42.25	3,296	13,890	17,186	370,329	12,757	277,105

Table 2 (continued). Daily salmon counts and escapement objectives at the Miles Lake sonar, 2005.

		Estimated daily escapement				Escapement objective	
Date	Stage height (m)	North Bank	South Bank	Daily	Cum.	Daily	Cum.
13-Jun	42.39	2,960	8,801	11,761	382,090	11,373	288,478
14-Jun	42.53	1,464	12,900	14,364	396,454	9,657	298,135
15-Jun	42.74	3,000	13,692	16,692	413,146	9,347	307,482
16-Jun	42.96	1,248	12,444	13,692	426,838	9,316	316,798
17-Jun	0	1,592	8,406	9,998	436,836	8,865	325,663
18-Jun	43.26	1,376	10,258	11,634	448,470	9,190	334,853
19-Jun	43.52	1,064	9,120	10,184	458,654	10,008	344,861
20-Jun	43.69	824	5,220	6,044	464,698	9,032	353,893
21-Jun	43.86	904	7,234	8,138	472,836	8,576	362,469
22-Jun	43.72	2,168	11,586	13,754	486,590	9,676	372,145
23-Jun	43.29	3,184	18,258	21,442	508,032	11,132	383,277
24-Jun	43.04	3,712	15,599	19,311	527,343	10,788	394,065
25-Jun	42.96	2,552	17,372	19,924	547,267	10,770	404,835
26-Jun	43.01	3,272	15,750	19,022	566,289	9,532	414,367
27-Jun	43.08	1,912	12,427	14,339	580,628	8,987	423,354
28-Jun	43.11	2,256	11,328	13,584	594,212	11,224	434,578
29-Jun	43.13	2,424	14,262	16,686	610,898	12,475	447,053
30-Jun	43.22	2,080	12,576	14,656	625,554	9,597	456,650
1-Jul	43.43	1,400	10,236	11,636	637,190	10,728	467,378
2-Jul	43.64	816	5,082	5,898	643,088	10,739	478,117
3-Jul	43.64	888	8,148	9,036	652,124	10,393	488,510
4-Jul	43.6	728	5,532	6,260	658,384	10,587	499,097
5-Jul	43.41	1,416	7,991	9,407	667,791	9,589	508,686
6-Jul	43.26	1,944	8,339	10,283	678,074	10,277	518,963
7-Jul	43.37	1,904	9,012	10,916	688,990	11,692	530,655
8-Jul	43.55	1,560	6,642	8,202	697,192	13,652	544,307
9-Jul	44.65	1,920	3,540	5,460	702,652	12,609	556,916
10-Jul	43.9	688	4,524	5,212	707,864	11,719	568,635
11-Jul	43.88	624	4,752	5,376	713,240	14,287	582,922
12-Jul	44.04	848	3,828	4,676	717,916	14,029	596,951
13-Jul	44.16	1,096	1,920	3,016	720,932	11,906	608,857
14-Jul	44.16	1,152	2,328	3,480	724,412	12,095	620,952
15-Jul	43.75	1,912	5,520	7,432	731,844	10,492	631,444

Table 2 (continued). Daily salmon counts and escapement objectives at the Miles Lake sonar, 2005.

Date	Stage height (m)	Estimated daily escapement				Escapement objective	
		North Bank	South Bank	Daily	Cum.	Daily	Cum.
16-Jul	43.54	2,536	4,428	6,964	738,808	8,399	639,843
17-Jul	43.75	1,400	4,374	5,774	744,582	6,997	646,840
18-Jul	43.56	2,296	5,892	8,188	752,770	6,157	652,997
19-Jul	43.09	3,448	7,134	10,582	763,352	4,570	657,567
20-Jul	42.88	2,320	7,488	9,808	773,160	7,221	664,788
21-Jul	42.93	1,200	6,276	7,476	780,636	7,249	672,037
22-Jul	43.06	1,872	6,378	8,250	788,886	4,948	676,985
23-Jul	42.85	1,264	6,588	7,852	796,738	5,309	682,294
24-Jul	42.76	2,776	8,214	10,990	807,728	5,564	687,858
25-Jul	42.74	1,944	7,824	9,768	817,496	4,732	692,590
26-Jul	42.84	7,062	1,032	8,094	825,590	5,043	697,633
27-Jul	42.99	952	4,716	5,668	831,258	6,126	703,759
28-Jul	43.11	904	4,728	5,632	836,890	4,899	708,658
29-Jul	43.14	896	4,536	5,432	842,322	4,091	712,749
30-Jul	42.97	752	5,310	6,062	848,384	4,200	716,949
31-Jul	42.56	496	5,388	5,884	854,268	4,106	721,055