PRELIMINARY DEVELOPMENT PLAN FOR U.S./CANADA BORDER SONAR PROJECTS IN THE YUKON RIVER DRAINAGE

Prepared By
U.S./Canada Joint Technical Committee
Sonar Planning Subcommittee

May 1991

I. INTRODUCTION

This planning document was prepared as a result of discussions from the Yukon River Border Sonar Planning meeting held in Whitehorse, Y.T., March 6-8, 1991. The purpose of the plan is to provide the US/Canada Joint Technical Committee (JTC) with an outline of key elements to initiate and develop hydroacoustic (sonar) salmon escapement projects on the mainstem Yukon and Porcupine rivers. This planning document includes discussions on project justification, recommended hydroacoustic technology, site selection, anticipated costs, agency commitments, as well as annual project objectives through the developmental period. It is anticipated that further planning update documents will be prepared as progress is made on selection of technical equipment, specific agency committments to the project(s), and as preliminary findings warrant.

As early as 1985, the JTC identified the need for a border sonar project on the mainstem Yukon River as one of several research priorities needed for more effective chinook and chum salmon fishery management and for eventual treaty implementation. This project did not progress beyond periodic discussions at JTC meetings, largely due to a lack of available funds. Special appropriations were obtained by the U.S. Fish and Wildlife Service (USFWS) to initiate a mainstem Yukon River border sonar project during the 1991 federal fiscal year (Oct.1 1990 - Sept. 30 1991). Recent interest in the Porcupine River border sonar developed during discussions between the Alaska Department of Fish and Game (ADF&G) and USFWS regarding projects needed to support treaty implementation. Elimination of the Fishing Branch River weir project in Canada, which monitored fall chum salmon spawning escapement to this major trans-boundary producing stream, was one of the primary reasons to add this as a possible sonar project.

Initiation of both border sonar projects was placed under the guidance of the JTC; thus, allowing interested parties the opportunity to participate in project development and implementation. Preparation of this plan by the sonar planning subcommittee represents the first step in this cooperative participation. The timeframe to develop and fully implement either border sonar project is anticipated to take a minimum of three to four years. Additional operational project plans will be prepared by the sonar planning subcommittee outlining specific procedures to accomplish annual objectives listed in Section VI of this plan.

II. JUSTIFICATION

Accurate and precise estimates of the number of chinook and chum salmon delivered to the U.S./Canada border are needed both for U.S./Canada treaty implementation and Canadian fishery management purposes. Estimating numbers of salmon during their migrations in large turbid river systems is primarily limited to two techniques: tag-recapture abundance estimation, and hydroacoustic enumeration.

Tag-Recapture Abundance Estimates

Visual estimation of salmon numbers on the mainstem Yukon and Porcupine rivers using towers, weirs, or aerial surveys is not possible because of the large volumes of water and turbidity levels characteristic of these systems. Advantages of a tagging program compared to hydroacoustic enumeration are: (1) operational costs may be substantially less; (2) information on stock run timing and fish migration rates can be examined; and (3) the required level of technical expertise is considerably lower.

Population estimates using the tag/recapture method are feasible, but have several inherent disadvantages. The validity of "Peterson-type" tag/recapture population estimate is dependent upon the following set of assumptions: (1) tagged fish suffer no higher level of mortality than unmarked fish; (2) no tags are lost nor recaptured tagged fish overlooked; (3) marked fish are caught at the same rate as unmarked fish; (4) marked fish are randomly distributed, or if not, the recaptures are; and (5) there is no recruitment (Ricker 1975). These assumptions can be examined for sources of error, but in an open riverine system biased estimates of the total population can easily be made.

An additional disadvantage of a tagging program is that results only provide a seasonal estimate of abundance as the turn around time required to acquire this information precludes its usefulness as an inseason management tool.

Sonar Enumeration Estimates

Sonar technology is widely used throughout the State of Alaska for enumeration of salmon species where accurate and timely estimates of escapement are necessary. Costs associated with equipment and personnel limit these projects to those rivers where management needs are most crucial. The ADF&G currently operates five "large river" hydroacoustic salmon counting projects. These projects are located on the Kenai River, Kuskokwim River, Noatak River, lower mainstem Yukon River at Pilot Station, and the Tanana River near Manley Hot Springs.

Thorne (1983) outlined the advantages and disadvantages of hydroacoustics over other assessment techniques. The advantages with a properly designed and implemented project include: (1) independence from fishery catch statistics, (2) a more favorable time scale, (3) relatively low operational costs, (4) low variance, and (5) potential for absolute population estimation.

The disadvantages or limitations include: (1) poor species discrimination, (2) limited target detection near the bottom and surface, (3) high level of equipment complexity, (4) high initial investment, and (5) potential bias associated with target strength and calibration (Thorne 1983).

Project Benefits

The following outlines the benefits associated with border sonar enumeration over tag-recapture estimates in terms of fishery management and U.S./Canada treaty compliance needs.

Mainstem Yukon River

Improve precision and accuracy of estimates of salmon passage by species across US-Canada border for:

A. Treaty compliance
   a. border delivery (chinook and chum salmon) for entire season.

B. Fishery management
   a. in-season run assessment by day or week.
   b. contribute to total Yukon River drainage run assessment.

The current Department of Fisheries and Oceans (DFO) tagging program depends on a number of assumptions and requires fishery tag returns before estimates can be calculated. The tagging program only provides a seasonal estimate and can not be used for in-season management because of slow turn around time for collection (recapture) of tags. It also requires substantial handling (marking) of fish.

Even though the DFO tagging program has inherent disadvantages, the program should continue on an annual basis for several years in conjuction with implementation of a border sonar project. This would be necessary to identify and evaluate any difference in border passage estimates generated from the two programs. Interim spawning escapement objectives and border delivery objectives for chinook and chum salmon entering Canada are predicated solely upon DFO tag-recapture population estimates. Sonar estimates may differ substantially from tag-recapture estimates requiring reevaluation of spawning escapement and border passage objectives.

Porcupine River

Improve precision and accuracy of estimates of salmon passage by species across US/Canada border for:

A. Treaty compliance
   a. border delivery (chum salmon) for entire season.

B. Fishery management
   a. in-season run assessment by day or week.
   b. contribute to total Yukon River and Porcupine River drainage run assessment.

The current run assessment program includes only the Sheenjek River (Alaska). Fishing Branch (Canada) and other U.S. and Canada stocks are not assessed.

III. SONAR EQUIPMENT ACQUISITION CONSIDERATIONS

Single beam, dual beam, and split beam sonar are the three technologies capable of counting salmon. The estimated costs and a summary review of advantages and disadvantages of each technology follow. Costs associated with each type of system assume a two bank sonar project and cable connected transducers deployed from each bank. Costs do not include other support equipment such as project boats and camp gear.

Cost Comparisons

Sonar Project Costs ($1000's U.S.)

Component	Single	Dual	Split
Echosounders (2)	26.0	52.0	70.0
Transducers (4)	6.0	18.0	20.0
Rotators (4)	32.0	32.0	32.0
Pods (4)	2.0	2.0	2.0
Oscilloscopes (2)	12.0	12.0	12.0
Cable (500 ft. each)	6.0	12.0	6.0
Chart Recorders	14.0	14.0	14.0
Visual Display Units	2.0	2.0	2.0
Computers - ESP (2)	-	48.0	-
Computers - Data Acquisition (2)	12.0	-	12.0
Computers - Data Processing (1)	10.0	10.0	10.0
Generators (2)	2.4	2.4	2.4
Test Fishing Boat, Motor, Gill nets,etc.	25.0	-	-
Total Capital Costs	149.4	204.4	182.4*
Operational Costs (3 mo) includes post season analysis and reporting	120.0	90.0	90.0

* Costs do not include applications software which maybe substantial.

System Comparisons

Advantages and Disadvantages of Single, Dual,
And Split Beam Sonar Systems

SINGLE BEAM

Pros

1. Technically trainable personnel are more broadly available (statistics vs hydroacoustics).
2. System technology is readily available, including applications software.

Cons

1. Cost is not substantially less for equipment acquisition given its more limited capabilities.
2. Test netting is required on an intensive schedule. This involves higher operational costs, fish disposal problems, liabilities of killing fish, and logistics associated with test fishing on a large scale.
3. There is not much future in terms of industry standards. This system lacks species/size and direction of travel capabilities.

DUAL BEAM

Pros

1. Addresses species composition (size class information) via acoustic size.
2. Substantially reduces the need for fish handling.
3. Reduces crew size relative to single beam due to elimination of test fishing.
4. System technology readily available, including applications software.
5. Three sources are available for supply, maintenance, and technical support.
6. Some agencies currently have an inventory of some dual beam equipment. This helps ameliorate concerns regarding backup equipment without additional costs.

Cons

1. Requires higher level of continued hydroacoustic expertise relative to single beam.
2. Costs may be somewhat higher for equipment acquisition than either of the other two systems.
3. Requires close monitoring of signal-to-noise ratio.
4. Incapable of determining direction of travel.
5. May not be the future industry standard with the move to split beam technology.

SPLIT BEAM

Pros

1. Provides direction of travel and size class information.
2. Size class discrimination capability superior to dual beam.
3. Less signal-to-noise sensitivity than dual beam.

4. May become industry standard as compared to dual beam.
5. Equipment costs may be less than dual beam.

Cons

1. Requires higher level of continued hydroacoustic expertise relative to single beam.
2. System procedures not yet developed, including applications software and riverine field experience.
3. Limited vendors available for supply, maintenance, and technical expertise.

Sonar Selection Process

The USFWS will prepare a solicitation for a riverine sonar system to be used for the Yukon River project this summer. A Sonar Selection Committee, appointed by the Contracting Office of the USFWS, will review and rate company proposals based upon their technical merit. An analysis of cost versus technical quality will determine the successful vendor. This decision is anticipated to be completed by October 1, 1991.

IV. SONAR SITE SELECTION CRITERIA

Realizing the inherent political ramifications of a jointly funded and operated sonar project, the sonar planning subcommittee will recommend several site locations based solely upon their technical and logisitical merits. Parameters involved in making these recommendations will include river bottom profiles, horizontal and vertical fish distributions, and river current patterns. Distance from the nearest town must also be considered since distant or remote sites require considerably higher operational costs and may slow project development time schedules. Once specific sites have been identified, research on land ownership titles will be conducted. Arrangements for leasing of private lands may be necessary.

Mainstem Yukon River

The mainstem Yukon River site surveys will cover the area from Eagle upstream to Whiterock. These surveys will include potential sites in the U.S., in Canada, and near the border.

Porcupine River

Porcupine River site surveys will cover two general areas: in proximity of the U.S./Canada border; and also well below the border, but above major U.S. salmon spawning tributaries.

V. CURRENT AGENCY COMMITMENTS

USFWS

The USFWS has committed capital funds exceeding $200,000 (U.S.) for purchase of hydroacoustic equipment. They have also obligated operational funds to begin project implementation in 1991. Two full-time biologists have been assigned for this project. The USFWS activities will include: attendance at a riverine hydroacoustics workshop in Anchorage, April 22-26; arrangements for technical presentations of sonar systems by vendors during the week of the sonar workshop; field training at ADF&G sonar facilities this summer; preparation of equipment contracts and purchases of sonar equipment; and assistance in Yukon and Porcupine rivers site selection surveys. They anticipate additional funds will be made available annually to proceed with project development.

ADF&G

The ADF&G currently has no funds available (nor immediately anticipated) to assist in this project. Staff time has been spent in U.S. interagency planning meetings and discussions which began in January 1991. The Department anticipates that staff time commitments will be reprioritized to continue participation in the sonar planning processes and assistance in site selection surveys. They will attend the hydroacoustic workshop and will also provide instruction for the workshop.

DFO

The DFO, like ADF&G, has no funds currently available. DFO is pursuing possible external funding through Economic Development Agency to become partners in these border sonar projects. The hydroacoustics workshop will be attended by DFO personnel and they will provide logistical support for Yukon River border site selections this summer.

VI. ANNUAL PROJECT OBJECTIVES

The following outline identifies general project objectives (by generic year) to be accomplished over a minimum four-year period. It should be emphasized that accomplishment of annual objectives are based on the assumption that necessary funds are available for each agency to participate in these projects. Realizing that adequate funding may not be available annually, yearly accomplishments are described by generic year. Year 1 objectives coincide with calendar year 1991, while other years may not coincide with consecutive calendar years.

Year 1 Objectives (1991)

1. Prepare border sonar planning document.
2. Initiate training of agency staff by attending a hydroacoustic workshop and visiting existing large river sonar facilities during operation.
3. Select sonar system technology and acquire as much sonar equipment as available funds allow.
4. Survey potential sites on the Porcupine and Yukon rivers.
5. Determine land status of potential sites.

Year 2 Objectives (Year not agreed upon)

1. Select optimal site(s) based on technical and non-technical factors and pursue land use agreements.
2. Acquire additional hydroacoustic and field support equipment necessary to implement project.
3. Establish field camps at selected site(s).
4. Fit sonar beams to selected site(s) and detect fish targets.
5. Continue personnel training opportunities.

Year 3 Objective (Year not agreed upon)

1. Operate sonar in testing mode, but run it as if it were fully operational.
2. Continue personnel training opportunities.

Year 4 Objective (Year not agreed upon)

1. Project is fully operational, counting data are provided for fishery management and public information utilization.

Literature Cited:

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada, Bulletin 191, Ottawa, Canada.

Thorne R.E. 1983. Hydroacoustics. Pages 239-240 *in* Nelson, L.A., and D.L. Johnson, editors. Fisheries techniques. American Fisheries Society, Bethesda, Maryland.

001083