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FIVE YEAR RESEARCH PLAN FOR

UPPER COOK INLET, ALASKA

By

Kenneth E. Tarbox

Bruce E. King

and

David L. Waltemyer

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TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

The Alaska Department of Fish and Game (ADF&G), Commercial Fisheries Division, has been an established fishery research entity in Upper Cook Inlet, Alaska (Figure 1) since statehood. A number of valuable fishery management programs have resulted from these research efforts. These include the design and refinement of hydroacoustic equipment for counting adult salmon in glacial river systems, the development of sockeye salmon (Oncorhynchus nerka) stock identification techniques, programs (entry pattern analysis) to estimate the total return of sockeye salmon entering the inlet prior to the commercial fishery, and the establishment of sockeye salmon escapement objectives for the major river systems. In addition, basic biological data (e.g. age, length, and weight) on the five species of salmon found in the inlet have been collected. Recently, documentation of the rearing requirements of juvenile sockeye salmon in glacial lakes systems has contributed significantly to the understanding of salmon behavior in these systems.

The future of Upper Cook Inlet, Commercial Fisheries Division, research programs can take many directions as the geographical size of the area and biological complexity combine to create unlimited opportunities. However, the resources available for investigation are limited and priorities for research must be made. In addition, the long term direction of research in Upper Cook Inlet has never been defined. Short term objectives have in some instances reallocated funds and personnel to projects whose merits have been suspect. This has resulted in the potential loss of useful data. Therefore the Upper Cook Inlet staff has prepared the following five year research plan to aid managers and the public in planning the allocation of personnel and budgets. The plan is presented in two parts. First, the staff realized that recent budget reductions have established a defacto priority list of projects. The continuation of these projects is recognized. However, within these projects technical improvements are necessary. In addition, a number of new projects are suggested which will provide a long term data base and hopefully result in new commercial fishery management options and direction.

EXISTING PROJECTS

Hydroacoustic Enumeration of Adult Salmon

Background

In the early 1960's the ADF&G contracted with Bendix Corporation to develop hydroacoustic equipment to count adult salmon. Counts from the Kenai and Kasilof Rivers started in 1968 and have been published annually from that date. In 1978 ADF&G installed hydroacoustic counters in the Susitna River and has operated in the mainstem of the River until 1982. Because of technical factors the counters were moved to the Yentna River, a tributary to the Susitna, in 1983 and have operated at this location to the present. Within the Crescent River system the counting operations have been ongoing since 1979. Annual reports of all counting operations are available. Recent publications include Namtvedt et al. (1979), King (1984, 1987, 1988), King and Tarbox (1984, 1986, 1987a, 1988) and Tarbox et al. (1981, 1983).

Objective

The 5 year objective is to increase the precision and accuracy of the hydroacoustic estimate of adult sockeye salmon entering the Kenai, Kasilof, Crescent, and Yentna Rivers.

Recommendation and Justification

The altered behavior of sockeye salmon as they pass over the existing counting substrate, associated with the Bendix side scan sonar unit, was documented by King (1988). Removal of the substrate has resulted in a more normal migration of sockeye salmon near shore and more consistent swimming rates. Therefore the use of substrateless counting systems should improve counting operations relative to the operational limits of the Bendix side scan sonar and it is **recommended that all Upper Cook Inlet sonar counting operations be converted to substrateless operations.** The priority of conversion is as follows: Crescent River (primarily because the technical complications from current substrate use are the greatest), Kenai River (land status concerns relative to mooring lines for substrate), Yentna River (technical and landowner concerns), and Kasilof River (manpower reduction).

The existing Bendix sonar data collection and analysis procedure require corrections in the equipment settings and raw data output for calibrations, post season adjustments for run timing and debris, and apportioning of sonar targets from fish wheel catches. To date no variance for the final escapement estimates has been calculated. However, various statistical techniques are available to address this issue. Therefore it is **recommended that variance estimates be established for all sonar estimates in Upper Cook Inlet.**

Salmon counting operations in Upper Cook Inlet have been limited to Bendix sonar counters for adult salmon and recently BioSonics,Inc hydroacoustic equipment for both adult and juvenile salmon. Within the Bendix equipment a number of models with different capabilities have been developed. Therefore **it is recommended that all available equipment be evaluated relative to selection of the best available equipment** for meeting the objective.

The existing sonar equipment in Upper Cook Inlet consist of between 8 and 12 counters at any one time. With the exception of the BioSonics equipment there is no documentation of the calibration of this equipment relative to source level, receiving sensitivity, target strength, gain or other operational parameters. Therefore **it is recommended that all sonar equipment be calibrated and a documentation file established for each unit.**

The ultimate objective of this research effort is to improve the estimate of the number of adult salmon entering the various river systems. In this context a number of assumptions about fish behavior have been made. For example, the existing Bendix counting operation must assume that all targets are moving upstream and that no downstream movement of counted targets has taken place. However, examination of this assumption in the mainstem Susitna River indicated that downstream movement may be significant. In addition, the Bendix equipment requires a measurement of fish swimming speed and is presently limited to a counting range of 18 meters from the transducer. Therefore, **it is recommended that the migratory behavior of adult sockeye salmon in the vicinity of the counting operations be assessed relative to upstream/downstream movement, vertical and horizontal distribution by species, and swimming speed.**

Offshore Test Fishing

Background

The offshore test fishing project was initiated as a pilot program in 1976. In 1977 the design of the test fish project was modified to follow an existing Bristol Bay program. The test fishery operated from Point Adams to Cape Douglas. In 1979 the test fishery location was moved to Anchor Point, where weather conditions were more conducive to fishing, and has operated annually at this location. Significant modifications to the original design have taken place and the program is an important component of the Upper Cook Inlet management data base. Results from this effort can be located in Waltemyer (1983a, 1983b, 1986a, 1986b) and Waltemyer and Hilsinger (1987).

Objective

The 5 year objective is to improve the precision and accuracy of the inseason estimate of the total sockeye salmon return to Upper Cook Inlet.

Recommendation and Justification

The success of the existing test fishery in estimating the total return of sockeye salmon to Upper Cook Inlet is dependent on the determination of catchability of sockeye relative to the total abundance of sockeye salmon passing the test fish location. In this context, the environmental conditions at the time of fishing may influence the catchability of sockeye salmon. These parameters may include tide stage, wind conditions, water temperature, salinity, wave height, or cloud cover. To date these parameters have not been evaluated in detail relative to program results. Therefore, **it is recommended that the existing data base collected over the previous 8 years of the program be examined for possible relationships to catch.**

The existing test fish program sample locations were established by systematic design (evenly spaced locations across the Upper Inlet at Anchor Point). Based on the systematic sample results this design was modified to place more effort in areas of known fish migratory pathways. It is **therefore recommended that the sample locations be further evaluated relative to the coverage of the migratory corridors into the Inlet.**

The existing test fish project assumes an instantaneous exploitation rate for the drift and set gill net fisheries which is used to estimate the residual fish in the fishing district. As a preliminary figure the staff has used 40 and 70 percent for the two fisheries, respectively. However, the actual exploitation rates have not been estimated based on run reconstruction analysis. Therefore it is **recommended that run reconstruction and exploitation rates by period be made for all previous years of data.**

Stock Identification of Sockeye Salmon

Background

The statewide salmon stock identification project was initiated in 1976. The first attempt at separation of sockeye salmon stocks of the inlet took place in 1977 and estimates of stock composition of the sockeye salmon fishery were made for each fishing season from 1977 to present (Bethe et al. 1980, Cross et al. 1981, 1982, 1983a, 1983b, 1985, 1986, 1987a, 1987b).

Objective

The 5 year objective is to improve the precision and accuracy of the estimate of the sockeye salmon production, by river system, in the commercial harvest.

Recommendation and Justification

The existing stock separation models require representative samples from the river systems of interest. In this context a number of issues have

been identified which questions the validity of the models. **It is therefore recommended that a reevaluation of model selection, representative value, and overall accuracy of the procedure be undertaken and modification of that procedure be implemented if warranted.**

The findings of above may require that the historical data base be adjusted or recalculated. The geographical distance of the Susitna River from the primary fishery has combined with delayed run timing of sockeye salmon migrating to that system to limit the "inseason" usefulness of the stock separation program. Therefore **it is recommended that this issue be examined relative to historical models and the use of recently developed bootstrap techniques.**

Salmon Catch and Escapement Sampling

Background

The sampling of adult salmon from the commercial harvest and the rivers of Upper Cook Inlet for age, sex, length, and weight data has occurred periodically since statehood. Major focus of investigations have been on sockeye salmon. Sampling of other species has been a lower priority. This has resulted in an incomplete data base for these species. In addition, the sampling of sockeye salmon has been limited to the major river systems and fisheries. Therefore incomplete data sets exists for these systems and fisheries prior to 1978. Following the initiation of the stock identification program in 1978 the sampling levels for sockeye salmon increased to adequate numbers for the major fisheries and rivers.

Objective

The 5 year objective is to improve the definition of the age and size composition of adult salmon returning to Upper Cook Inlet.

Recommendation and Justification

The current sockeye salmon sampling program has not been evaluated relative to the representativeness of the samples collected. The size of the commercial drift gill net fleet (600 vessels), the number of processors and delivery times and skewed harvest within the fleet may affect the sampling design. No concentrated effort has been expended to date to define a representative sampling program. Therefore **it is the recommendation of the staff that a program be designed to assess this issue. Similar concerns also exist for the second major fishery (eastside set gill net fishery).**

The existing sockeye salmon sampling program does not allow time to sample every major fishery on every sampling period. Therefore, the days for which fishing periods occur but no samples are collected must be imputed using prior or post sampling dates. Potential bias and error associated with this approach has not been documented. Therefore **it is recommended that the historical data be examined relative to this issue.**

The physical characteristics of some systems have combined with budget limitations since statehood to limit the sampling effort for age,length, and weight samples in various river systems for all species. In a number of instances the sampling effort was below statistical minimums and therefore of limited use. **Therefore it is recommended that a sampling program be designed for all species in both the commercial fisheries and rivers and that sampling effort meet these levels. In the case where the collection of samples is limited by budget restrictions the use of test fisheries and associated funds should be explored. This is particularly important for the Susitna and Crescent River systems.**

The importance of minor sockeye salmon systems to the overall production of sockeye salmon for the inlet has recently been documented through studies associated with various industrial developments. The absence of data on these systems has impacted a number of other programs concerned with salmon production in the major systems. For example the stock separation and test fish programs have been impacted by not including these systems in the analysis. Therefore, it is recommended that a minor system sampling program be identified and implemented.

Escapement Objective Definition

Background

Sockeye salmon escapement objectives were first established for the Kenai and Kasilof Rivers in 1969. These initial escapement goals were raised three times for the Kenai system and twice for the Kasilof River system. The sockeye salmon escapement goals for the Susitna and Crescent Rivers were set in 1979. The history of sockeye salmon escapement goals is presented in Tarbox (1986). No escapement objectives have been established for the other salmon species of the inlet.

Historically, sockeye salmon escapement goals have been established by spawner/return relationships for the drainage of interest. However, recent information suggest that this relationship may not be appropriate for glacial systems or drainages with multiple subsystems.

Objective

The 5 year objective is to develop and implement an adult and juvenile sockeye salmon production model for the Susitna, Kenai, Crescent, and Kasilof drainage.

Recommendation and Justification

The Susitna River system is probably the most complex river system in Upper Cook Inlet. There are at least 15 sockeye salmon rearing lakes within the drainage with significant differences between them in terms of physical and chemical characteristics. The overall sockeye salmon production is the net result of both environmental and biological limitations within each of

these subsystems. To date no data have been collected on the Susitna River subsystems relative to sockeye salmon production. **Therefore it is recommended that a subsystem evaluation program consisting of counting of adult salmon and estimating freshwater juvenile salmon production be developed.** The form of this program is envisioned to consist of weir, tower, or hydroacoustic counting of adults, hydroacoustic enumeration of juveniles within the rearing lakes, and collection of associated limnological data.

The total production of adult sockeye salmon from the Susitna drainage has been estimated from combining escapement estimates from mainstem sonar with estimates of harvest from the stock separation program. In this context the escapement estimates have not been verified by any technique and in some years mainstem counting operations have been terminated because of the physical limitations of the Susitna River environs. Alternate counting techniques to sonar were proposed and implemented in some years (e.g. fish wheel and mark/recapture estimates) by other investigators (Susitna Hydroelectric Studies). However, a full evaluation of these methods has not been made. Preliminary evaluation of collected data has indicated technical difficulties with meeting assumptions associated with the mark/recapture population estimate technique. **Therefore it is recommended that a full evaluation of historical data be completed relative to the usefulness of fish wheel/mark-recapture techniques. In addition, it is recommended that mainstem sonar techniques be further evaluated for long term escapement monitoring.**

The Kasilof River drainage has been studied extensively for the past 6 years and the production of sockeye salmon has been shown to vary dramatically during that time period (Flagg et al. 1987). Smolt production has ranged from 3 million to over 15 million/brood year. Types of data collected include limnological, rearing fry estimates from hydroacoustic surveys, smolt estimates, and adult return analysis by age class. **It is recommended that this program be continued and a production model developed from the data collected.**

The Kenai River drainage is the major sockeye salmon producing system in Upper Cook Inlet. However, data on the rearing environs of sockeye salmon are essentially non-existent. **Therefore, it is recommended that a program similar to the Kasilof River be implemented in the Kenai River system. At a minimum hydroacoustic estimates of rearing fry, basic physical/chemical parameters of the system, and adult returns should be compiled.**

NEW PROGRAMS

Computer Data Base for Escapement Information

Presently within Upper Cook Inlet the harvest data is compiled in user friendly computer format for use by the staff and public. This feature has allowed various offices to generate and meet public and scientific needs in a time efficient manner and without duplication of effort involving Area staff. Therefore it is the opinion of the Research staff that a similar

program be developed for all Upper Cook Inlet escapement data. It is estimated that this task would not require more than 1-2 man months of effort.

Analysis of Commercial Harvest Data.

The historical harvest data have only been partially examined for run timing analysis and interaction between fisheries. Therefore it is recommended that substatistical area analysis and relationships be evaluated for potential use in developing management options and research program development.

Climatic and Hydrological Data Base Development

The production of sockeye salmon and other salmon species in Upper Cook Inlet is without question influenced by the climatic and hydrological regimes of the area. Therefore it is recommended that these data be stored and accessed through user friendly programs similar to the harvest data. Recent evaluation of sockeye salmon production in Tustumena Lake (Kasilof River system) has reenforced the importance of collection and analysis of these data Inlet wide.

Evaluation of Eastside Set Net Fishery.

The continuing expansion of the eastside set gill net fishery and allocation conflict between user groups requires precise information on the operation of that fishery. The relationship of harvest data to effort and interaction between species has not been defined. Therefore, it is recommended that a program to define the specific operational characteristics of the eastside set gill net fishery be identified.

Marine Environment-Oceanographic Studies

Within Upper Cook Inlet the development of sonar counting techniques in the Kenai and Kasilof Rivers was a major technical achievement which furthered the ability of the Department to meet management objectives. While salmon counting within the various river systems is still developing with more accurate and precise techniques it is unlikely that these refinements will significantly alter management options. In other words a technical plateau has been reached. It is the opinion of the research staff that the next major advancement in management options will be achieved by understanding the marine environment, and the migratory behavior of salmon within that environment. Therefore this program recommendation is to continue to develop programs which help to understand the physical and chemical parameters of the marine environs. Data collection from combined State and Federal programs is viewed as a logical route.

Spawning Distribution of Kenai River Sockeye Salmon

Preliminary analysis of recent sockeye salmon returns to the Kenai River system suggest that spawner distribution may be as important as number of spawners. This is not inconsistent with numerous other studies in other river systems. Therefore it is recommended that a radio tagging or similar program be developed to define the spawner distribution of adult sockeye salmon in the Kenai River system.

Chum, Pink, Coho, and Chinook Salmon Escapement Studies.

The success of the sockeye salmon escapement monitoring programs have been previously cited. The absence of similar programs for other species is a technical void in the Upper Cook Inlet data base. In the 28 years since statehood the commercial management of these stocks still is dependent on imprecise catch per unit data from the fishery. Therefore, in order to advance management precision and options, escapement estimates for Susitna River chum, coho, and pink salmon and Kenai River chinook, coho, and pink salmon should be made. The shared responsibility for management of these stocks between Sport and Commercial Fisheries Divisions implies a joint program approach.

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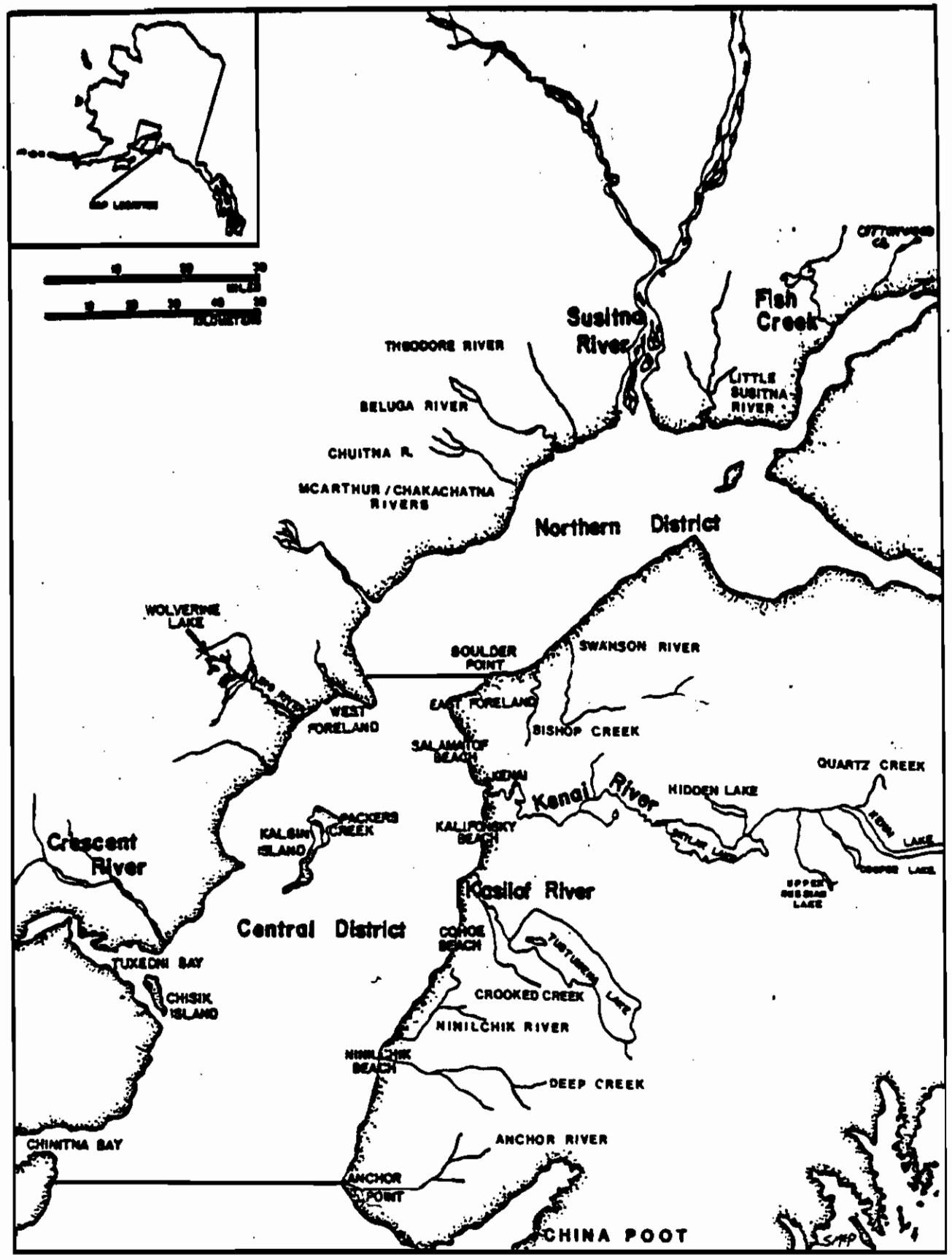

Figure 1. The Upper Cook Inlet area showing the locations of the Northern and Central Districts and the major sockeye salmon spawning drainages.