MORANDUM

State of Alaska

TO: Susitna Program Review Team

DATE: February 14, 1986

FILE NO:

TELEPHONE NO:

FROM: Ken Florey, Regional Supervisor
Division of Commercial Fisheries
Department of Fish and Game

SUBJECT: Review Findings

The attached final draft report "Susitna River Aquatic Studies Review, Findings and Recommendations of the Susitna Program Review Team" is provided for your review. I want to thank the team for their excellent comments on the draft; we've attempted to incorporate your technical comments wherever appropriate. Please take one more quick look at the report; particularly in regard to how your comments were treated and let me know by close of business on March 7 if you have additional comments. If I don't hear from you by then, I'll assume that you are satisfied with the report and we will send it through headquarters on to the Alaska Power Authority. Thank you for your help.

cc: K. Tarbox
C. Meacham
D. Schmidt
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Susitna River Aquatic Studies Review

Findings and Recommendations of the

Susitna Program Review Team

Prepared by

Richard Cannon

Division of Commercial Fisheries

Susitna Aquatic Studies Program

Alaska Department of Fish and Game

February 1986

The following report provides a discussion of the background and findings of the 1985 Susitna program review which was held on October 2 and 3 in Anchorage by the Alaska Department of Fish and Game.

INTRODUCTION

Commissioner Collinsworth in his June 18, 1985 memorandum (Reorganization of the Susitna Aquatic Studies), assigned the project coordinator of the Susitna Aquatic Studies program under the direction of the Commercial Fisheries Division regional supervisor, Central Region with the responsibility for planning and coordinating all departmental salmon escapement activities on the Susitna River. In addition, the coordinator was to administer the contract between the Alaska Power Authority (APA) and the Division of Commercial Fisheries. The coordinator was also instructed to prepare a technical data report which summarized all salmon escapement data collected to date for the Susitna River by the combined efforts of the Divisions of Sport Fisheries and Commercial Fisheries and was to coordinate a cooperative effort among the fisheries divisions to ensure proper planning for future Susitna River escapement studies.

In order to accomplish these tasks, the Division of Commercial Fisheries has initiated the following: 1) staff orientation and coordination activities for staff assigned to Susitna River projects, 2) the preparation of the Susitna salmon escapement summary, and 3) a Susitna program review.

I. <u>Coordination</u> Staff orientation and coordination efforts have included information exchange, joint field inspections of various projects, and combined Central Region/Susitna Aquatic Studies staff planning meetings. Although this process is just beginning, significant improvement in communication and cooperation among the various departmental projects operating on the Susitna is already evident. These efforts will continue with an emphasis on including more involvement by Sport Fisheries Division regional staff in the future.

II. <u>Data Summary</u> A first draft of a "Susitna Salmon Escapement Summary Report" has been completed and will be available for departmental review in January. The report presents escapement data collected to date by tributary and/or river reaches of the Susitna. The information will be a available in a bound report format and on computer disk. This summary should prove very useful during planning for future Susitna salmon stock assessment programs, developing management plans, and preparing board reports.

III. <u>Program Review</u> The end of the 1985 open water field season will complete the final year of aquatic baseline studies which have been funded to characterize the resources of the Susitna River and to assess potential impacts resulting from construction and operation of the proposed hydroelectric project. Fisheries data collected by the Department for the Susitna during past years with particular emphasis given to the last five years of aquatic habitat evaluation will form the basis for impact assessment and mitigation plans to be prepared by APA.

Beginning in 1986, the objectives of the hydropower development program will undergo some important changes. Assuming the state will move forward with construction of the dams, a long-term fisheries population monitoring program will be initiated. This shift in direction of the program provides the Department, not only the opportunity to assess its past data collection programs related to the hydropower project, but to evaluate and to better coordinate all of our fisheries programs for the Susitna.

A program review of all its fisheries projects on the Susitna River was held to assist the Division plan its long-term fisheries monitoring and stock enumeration programs. A review team was formed which included the South Central regional supervisors from the Divisions of Habitat, Commercial Fisheries, and Sport Fisheries, and the chief biometricians from the Commercial Fisheries and Sport Fisheries Divisions (Table 1). The team was asked to review the Divisions' fisheries study projects to evaluate 1) technical merit, 2) cost effectiveness, and 3) relevance to primary management goals.

Table 1. Susitna Aquatic Review Team.

Review Team Staff [a/]	Position	Division	Phone Number
Paul Krasnowski	Regional Supervisor	SPORT FISH Division	267-2168
Michael Mills	Biometrician III	SPORT FISH Division	267-2369
Kenneth Florey	Regional Supervisor	COMMERCIAL FISHERIES Div.	267-2104
Douglas Eggers	Biometrician III	COMMERCIAL FISHERIES Div.	267-2104
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The Division presently has two primary management goals for the Susitna. The first goal is ENSURE THAT OPTIMUM SPAWNING ESCAPEMENTS ARE MAINTAINED FOR SUSITNA RIVER STOCKS. The second primary goal addresses monitoring potential changes resulting from the construction and operation of the Susitna Hydroelectric Project on fish populations and their habitats. More specifically the goal is DESCRIBE THE NATURAL PRE-PROJECT VARIATIONS IN FISH POPULATIONS AND THEIR HABITATS AT A LEVEL OF RELIABILITY NECESSARY TO DETECT AND EXPLAIN POSSIBLE FUTURE CHANGES CAUSED BY HYDROELECTRIC DEVELOPMENT. The review team was asked to use the following list of questions to structure their comments and recommendations.

1. Do the objectives of the proposed long term monitoring projects appear to adequately address the Division's primary goals? How might project objectives be modified to more clearly address our goals?

2. If you believe that technical difficulties associated with the project may exist, what are they and how might they be remedied?

3. Could the sampling programs be modified to reduce project costs without unreasonably sacrificing technical quality?

4. What priority should you give these projects in terms of meeting the Division's primary goals?

The basic format for the review employed an outline similar to the 1984 project review for the Kenai River Chinook Program. Each project leader submitted an executive summary and a more detailed operational plan for their respective projects. These materials in addition to some additional background information were organized into a briefing book which was distributed to the review team.

During the first session, six divisional projects on the Susitna were presented. These included: 1) Lower River Salmon Escapement, 2) Middle River Salmon Escapement, 3) Middle River Salmon Outmigrant Evaluation, 4) Lower River Spawning Habitat Evaluation, 5) Middle River Resident Fish Study, and 6) Aquatic Habitat Modelling. The first of these projects represents and ongoing effort by the Division to develop an annual estimate of total escapement for all salmon species in the Susitna. The information is primarily used by the Division to set and evaluate post-fishing season escapement goals for Susitna River salmon. The remaining five projects are all part of the five year APA baseline studies program which will be completed during FY 86.

Each project leader presented an overview of their respective project which included project objectives, experimental design, sample sites, assumptions, sources of error, and major project results and conclusions.

The first set of presentations provided the review team with an opportunity to examine existing fisheries programs on the Susitna. During the second session, a proposed long-term program for monitoring hydroelectric caused impacts on fisheries resources was outlined and discussed. Because the proposed monitoring program consisted primarily of a continuation of existing projects, the team decided to direct their comments and recommendations to those projects which may be continued. In addition, the team wanted to specifically address the problem of widely varying population estimates for salmon in the lower river. Various strategies for estimating total Susitna salmon escapements were also discussed by the team, however; it was decided to postpone developing any specific recommendations on this subject until results of a sonar research program are available and a clearer picture emerges concerning the future of APA funded studies.

FINDINGS AND RECOMMENDATIONS

The findings and recommendations of the Susitna review team are presented below. This section of the report is organized into three subsections: 1) adult salmon population estimates, 2) long term monitoring of salmon resources, and 3) long term monitoring of resident fish. Each subsection provides a summary description of the project (i.e. problem statement, scope, objectives, discussion of assumptions) followed by the review team's comments. A summary of the review team's findings and recommendations is provided on pages 42-46.

I. Adult Salmon Populations Estimates

A. Problem Statement

Salmon stocks utilizing the lower and the middle Susitna River are one facet of the fisheries resource that may be impacted from operation of the proposed hydroelectric development at Devil and Watana canyons. Because of this potential impact, APA has contracted the Department to provide baseline data on the escapement of anadromous fish to the middle and to a lesser extent, the lower river reaches.

B. Scope

Adult salmon captured with fishwheels were tagged and released at Flathorn, Sunshine, and Curry stations (Figure 1). Sonar counters and tag/recapture methods were used concurrently at Sunshine and Talkeetna stations in 1981 and 1982. Sonar counters were used to enumerate salmon populations in the Yentna River in 1981-1985. Tag recovery and spawning ground surveys were conducted in all middle river sloughs and streams and to a limited extent in lower river sloughs and streams. Population estimates were derived by the Petersen method. Tag recoveries were also used to evaluate the rate of travel between fishwheel sites. The adult salmon population parameters (i.e., age, length, and sex) were determined from a subsample of the fishwheel catch.

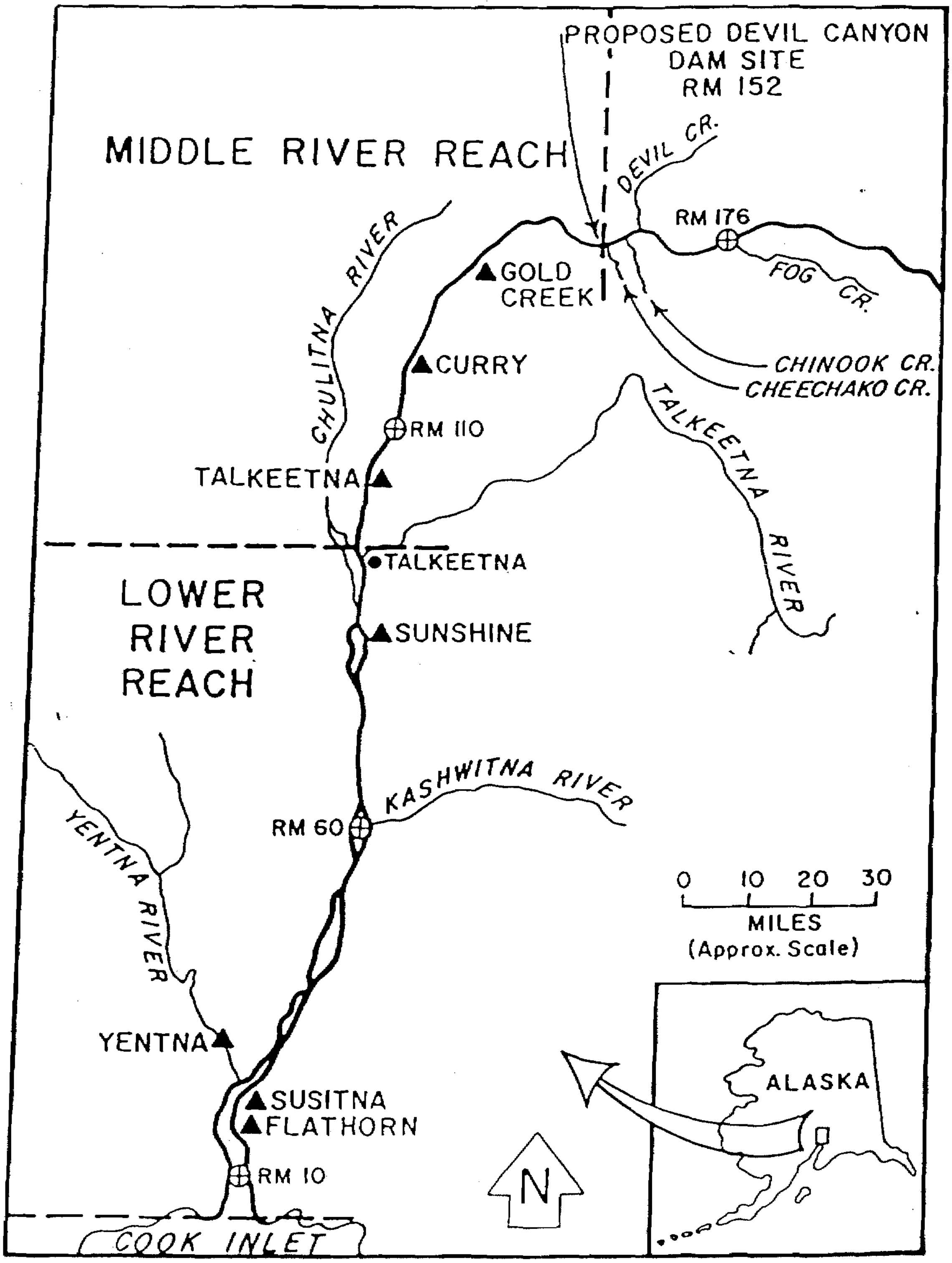

Figure 1. Location of Susitna River study locations.

C. Objectives

1. Determine the abundance of sockeye, pink, chum, and coho salmon at Flathorn (1984-1985), Yentna (1981-84), Sunshine (1981-85), Talkeetna (1981-84), and Curry (1981-85) stations. Also, determine the abundance of chinook salmon at Flathorn (1985), Sunshine (1982-85), Talkeetna (1982-84), and Curry (1982-85) stations. See Table 2.

2. Evaluate the migrational timing and migrational characteristics (rates of travel and bank/channel preference) of adult salmon at stations operated from 1981-85.

3. Monitor the age, length, and sex composition of the adult salmon escapements at the locations and years defined in objective 1.

4. Assess the extent of adult salmon spawning in middle river side channel, main channel, slough, and tributary habitats (1981-85).

5. Assess the extent of adult salmon spawning in lower river main channel, side channel, slough (1981-84, except 1983,) and tributary stream mouth (1984-85) habitats.

Table 2. Population estimates by location and year for salmon species

SAMPLING LOCATION	YEAR	ESCAPEMENT [a/] CHINOOK	SOCKEYE [b/]	PINK	CHUM	COHO	TOTAL
Flathorn Station	1984	c/	605,800	3,629,900	812,700	190,100	5,238,500
Yentna Station	1981		139,400	36,100	19,800	17,000	212,300
	1982		113,800	447,300	27,800	34,100	623,000
	1983		104,400	60,700	10,800	8,900	184,800
	1984		149,400	369,300	26,500	18,200	563,400
Sunshine Station	1981	c/	133,500	49,500	262,900	19,800	465,700
	1982	52,900	151,500	443,200	430,400	45,700	1,123,700
	1983	90,100	71,500	40,500	265,800	15,200	483,100
	1984	121,700	130,100	1,017,000	765,000	94,700	2,128,500
Talkeetna Station	1981	c/	4,800	2,300	20,800	3,300	31,200
	1982	10,900	3,100	73,000	49,100	5,100	141,200
	1983	14,400	4,200	9,500	50,400	2,400	80,900
	1984	24,800	13,100	177,900	98,200	11,800	325,800
Curry Station	1981	c/	2,800	1,000	13,100	1,100	18,000
	1982	11,300	1,300	58,800	29,400	2,400	103,200
	1983	9,700	1,900	5,500	21,100	800	39,000
	1984	18,000	3,600	116,900	49,300	2,200	190,000

a/ Escapement estimates were derived from tag/recapture population estimates except Yentna Station escapements which were obtained using side scan sonar.

b/ Second-run sockeye salmon escapements only.

c/ Chinook salmon were not monitored for escapement.

D. Discussion of Methods

The tag/recapture projects used the modified Petersen estimator and the sonars were 1980 model Bendix side scan units. There were discrepancies between population estimates from sonar and estimates from the tag/recapture method. Both estimates have inherent deficiencies.

It should not be assumed that all fish pass over the sonar substrate. The sector distribution of salmon will vary with site and species with an undetermined number of salmon passing beyond the counting range. A major source of error present in sonar counts is related to the methods of apportionment and the bias inherent in those methods. Although all fishwheels used to apportion counts were in close proximity to the counters, it must be recognized that fishwheels are species selective. The apportioned sonar counts would then reflect the selected catchability of the fishwheel. In addition, sonar counters are adjusted for fish velocity and sensitivity, thereby introducing an unknown variance component into the counts.

Five assumptions were made for estimating population size using tag/recapture methods and the Petersen estimate in particular. Failure to meet the following assumptions will bias the population estimate.

1. Either the capture of fish for tagging or the subsequent capture and/or observation of fish to determine the tagged/untagged ratio was random with respect to the population.

2. There was no differential mortality between tagged and untagged salmon.

3. Tagged salmon mixed randomly within the population.

4. Recovery of tagged salmon was not influenced by the tag.

5. There was no unknown tag loss.

In summary, both methods of enumerating salmon have potential drawbacks but at this point, they represent the state of the art in estimating population sizes in glacial river systems.

G. Review Team Comments

The review team focused its attention on unexplained differences in population estimates generated by sonar counts and tag/recapture methods for Susitna River salmon. As an example, the estimate for sockeye in 1984 for Flathorn Station was discussed. An escapement of 605,800 fish at Flathorn was calculated from tag/recapture data; the estimate upriver at Sunshine Station was 130,100 fish. Most of the 475, 700 sockeye which don't move past Sunshine should be accounted for by the Yentna escapement and spawning areas between Flathorn and Sunshine stations. The sonar count for Yentna sockeye in 1984 was 149,400 fish; thus an estimated 326, 300 sockeye should be spawning in the river reach between Flathorn Station and Sunshine Station. However, based on our present knowledge of sockeye production in the lower Susitna, this difference can not be explained biologically.

Sampling error associated with either the Yentna sonar estimate being negatively biased and/or the Flathorn (tag/recapture) estimate being positively biased have been offered as explanations at least in part for these differences. It is generally accepted that both the tag/recapture estimates and sonar counting techniques have inherent biases. A major source of error associated with sonar is species apportionment which in a multi-species, multi-stock system like the Susitna is extremely difficult to determine.

Use of fishwheels for species apportionment and capturing fish for tagging was discussed by the review team. Fishwheel catch data strongly suggests that individual wheels (sites) can be selective for species and size classes within species and that catch efficiency at a site can vary within and between seasons. It is acknowledged that fishwheel capture is not random with respect to the population.

Selection of fishwheel sites is an important consideration for planning future monitoring programs. The effect of milling on catch data and tag/recapture estimates for the Sunshine and Curry fishwheel sites has been proposed as an explanation for large differences between tag/recapture population estimates and estimates derived from spawning ground counts. Bank migration and cross-channel migration patterns between wheels is suspected at some sites. Because cross-sectional migration patterns at any site are probably related to velocity gradients near the bottom which vary with changes in flow and often shifting channel morphology, comparison of fishwheel data between sites and even for a given site over time may be suspect.

Preliminary results from the (Biosonics) hydroacoustic study conducted last summer of the cross-sectional distribution of migrating salmon at Susitna Station (just upriver from Flathorn) suggest that a high degree of within season variation in spatial distribution of migrating salmon occurs at this site. Some mid-channel migrational distribution for all salmon species was observed, however, approximately 95% of the migration was identified near the east and west banks. These results emphasize the importance of developing a monitoring strategy for a site based on the distributional patterns of the fish.

The review team identified a problem associated with the sample design employed for tag/recapture population estimates. Because fish are not captured randomly in fishwheels for tagging, recapture on the spawning grounds must be random in order to develop a valid Peterson estimate. Stream surveys used to obtain tagged/untagged ratios on the spawning grounds have been predominately focused on middle river spawning areas (above the three rivers confluence). Major spawning areas in the Yentna River, Chulitna River, and Talkeetna River receive less survey effort.

Because large numbers of fish were tagged and intensive surveys in the middle river resulted in a relatively high percent of recaptures, the precision of population estimates has been reasonably good; however, due to the violation of assumptions, the accuracy of the estimates are questionable. The relatively high sockeye salmon estimate for Flathorn Station, which was discussed above, might be explained by this error in the sample design. Yentna bound sockeye tagged at Flathorn would be lost to the surveyed sockeye population, however; this loss was not considered in the calculation of the population estimate. If the proportion of tagged sockeye migrating up the Yentna was significantly larger than those continuing up the Susitna, a large overestimate of the population would result.

Currently, the stream survey tag recoveries use visual assessment of the number of tagged and untagged fish present. This data is useless for the population estimates because the tag number cannot be recorded. If this is to be continued, a less biased method of recovery should be used. Sampling a portion of the surveyed streams with beach seines would provide a better methodology for determining the number of tagged and untagged fish present. This method would be especially beneficial in areas where the streams are highly turbid due to glacial influence or run-off. In addition, individual fish would be handled and the incidence of tag scars would allow a better estimate of tag retention rates.

Overall, the tag/recapture program for the Susitna was viewed by the team as beneficial to the Department and a high priority. Population estimates for Sunshine Station coupled with Yentna sonar counts presently provide the only indicator available to the Department for evaluation and establishment of post-season escapement goals for the Susitna. The team concluded that sample design problems for tag/recapture estimates can be addressed and resolved.

The Program Review Team recommended the following actions: 1) Compare tags recovered at fishwheels on the Yentna and Susitna to develop some indication of how tagged fish are distributed. If Yentna ratios are higher than Sunshine, it may be possible to account for loss of tagged fish migrating up the Yentna. 2) Numbered tag recovery data from surveys and fishwheels should be evaluated to assess differences in gear efficiency among fishwheel sites. 3) A time stratified population estimate should be employed in the future. The need for stratification by size (length of fish) should also be evaluated for salmon species when different capture probabilities are suspected for various size groups in the population. 4) Spawning ground surveys should be conducted throughout the drainage (more random) to minimize the sample design problem discussed above. 5) Employ capture methods (i.e. beach seines) which would allow tag recoveries rather than visual counting methods on the spawning grounds so that size stratification and tag retention can be more effectively addresed in the future, and 6) The Chief Fisheries Scientist Office within Commercial Fisheries Division should consider the species apportionment problems associated with sonar counts on the Susitna as a high research priority.

II. Long-Term Monitoring for Salmon

A. Problem Statement

Hydroelectric development may impact the fish resources of the middle river which has been defined as the reach extending upstream from the three rivers confluence near Talkeetna to Devil Canyon. A long-term plan to monitor natural variability in the numbers of salmon which utilize the middle reach needs to be developed. The design should provide an accurate measure of variability in Susitna River stocks under natural conditions which could ultimately be compared to variability under with-project conditions.

This proposed strategy introduces a conceptual approach on how this task might be accomplished by monitoring the adult salmon and juvenile salmon outmigration from the middle river reach. Some additional approaches which could be explored are also mentioned.

B. Objective To develop a long-term monitoring plan which will provide the capability to detect hydroelectric development related impacts to salmon produced in the middle reach of the Susitna River.

C. Procedures The basis of this proposal is that natural variation in pre-project adult escapement and juvenile outmigration will be defined and quantified so with-project impacts, if any, can be detected. With-project variation would have to be outside the pre-project variation to be considered project impact. This strategy suggests that pre-project variation can be described by monitoring over time a Survival Monitoring Index (SMI) based on annual fry to adult ratios. This plan would require the annual collection of CPUE data at two points, a "treatment" and a "control". The objective is to monitor the SMI in the middle reach of the Susitna River (the treatment) and compare it to the SMI of a control reach. The ratio of the treatment to the control would be monitored for several years under natural conditions. A basic assumption is that any post dam (i.e., with-project) change in the ratio outside of the natural variation would indicate a dam-caused effect.

1. Treatment Adult salmon CPUE data for the treatment population would be collected with fishwheels at Curry Station (RM 120). There already exists five years of adult data at this location. Juvenile CPUE data would be collected at either Curry or Talkeetna station (RM 130). Juvenile data has been collected at Talkeetna Station for the last four years. The rationale for proposing that the outmigrant data collection be moved to Curry is simplicity of logistics. It is untested if the data from Talkeetna would be comparable to Curry if past data were to be used. Data should be collected at both points for several seasons to test the assumption that they are comparable.

2. Control Adult CPUE data for the control would be taken at Sunshine Station (RM 80) with fishwheels. Five years of adult data have been collected at this site. The juvenile data would be collected near the Parks Highway Bridge (RM 83) just upstream from Sunshine Station where the river flows through a single channel. A consideration regarding the future use of CPUE data is that the sampling design associated with past studies has emphasized maximizing catch efficiency to either mark adults or recapture juvenile fish for mark recapture population estimates rather than maintaining a constant fishing efficiency. The maintenance of a constant fishing efficiency or at least an unbiased estimate of it would be needed to use CPUE data as an index to population size.

3. Calculations A probable way of calculating fry to adult ratios is to base the ratio on a CPUE index of the number of adult and juvenile salmon for the years in question. The ratio is defined:

$$\text{Fry/Adult Ratio} = \frac{\text{Outmigrant Index}}{\text{Inmigrant Index}}$$

Major sample design questions are how to obtain the required indexes and how to estimate their variances and the variance of the ratio. For adult salmon, the fishwheels are operating before the fish arrive and continue operating until virtually all of the fish have passed by the fishwheels on their way upstream; so it is fairly easy to convert each day's CPUE to a 24 hour CPUE and then sum over the entire season. The period when the fishwheels are operating has been and should remain constant from year to year.

Developing a CPUE index for juveniles poses some additional problems. Ideally, the period for which the outmigrant traps is operated would be constant from year to year relative to the timing of outmigration (Figure 2). The peak outmigration

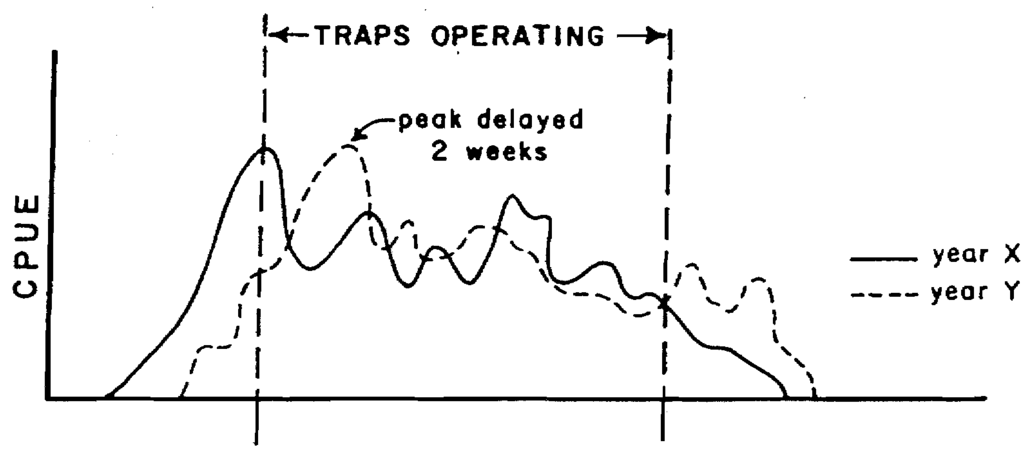

Figure 2. Operating Period

would have to be detected annually. This may not be possible however, because climatic differences from year to year change the timing. There is also evidence that some fry outmigrant under the ice before the outmigrant traps are in place. To resolve this problem, the CPUE might be summarized by adjusting to a 24-hour period, for all those days when the CPUE exceeds an empirically derived percentage of the peak 24 hour CPUE for the entire season. This method would result in an index that would be comparable from year to year provided that the pre-or post-season outmigration rates did not exceed the percentage selected.

After several years of data have been collected, the inter-annual variance of either the adult on juvenile indices could be estimated by using the variance of the mean of several years of indices. This may best be approached by taking the mean of the index from 0-10 percent, 11-20 percent, etc. of the cumulative migration. Calculation of these adult and juvenile indices would be done for both the treatment and the control populations; and then the one number which would be calculated each year is:

$$\text{Survival Monitoring Index} = \frac{\text{Fry/Adult Ratio for Treatment}}{\text{Fry/Adult Ratio for Control}}$$

4. Variance/Structure The ability to statistically detect change beyond that occurring naturally is the basic goal of any environmental monitoring program. It is hoped that it will be possible to detect dam-caused change in the salmon populations of the middle Susitna River with this proposed methodology.

Variance arises from both natural processes and from sampling. We can probably assume that the sampling variance is the same for the treatment and the control because similar methods will be used at both areas. We also have to assume that the factors affecting year to year natural variation work equally on both important ratios.

The survival monitoring index (SMI), is probably under natural conditions somewhere around one because survival in the two areas should be roughly equal. Let's assume for a moment that the dam did cause a substantial decrease in the fry/adult ratio for the treatment. A depiction of what time series plots of fry/adult ratios and the SMI might look like are presented in Figure 3.

The question we would want to ask then is whether the drop in the SMI was significant. If the fry/adult ratios for the treatment and the control have large variances, then only a large change over a long period of time in the SMI will be statistically detectable.

It is not possible to "cancel" these large variances by dividing the two. So the question now is what percentage

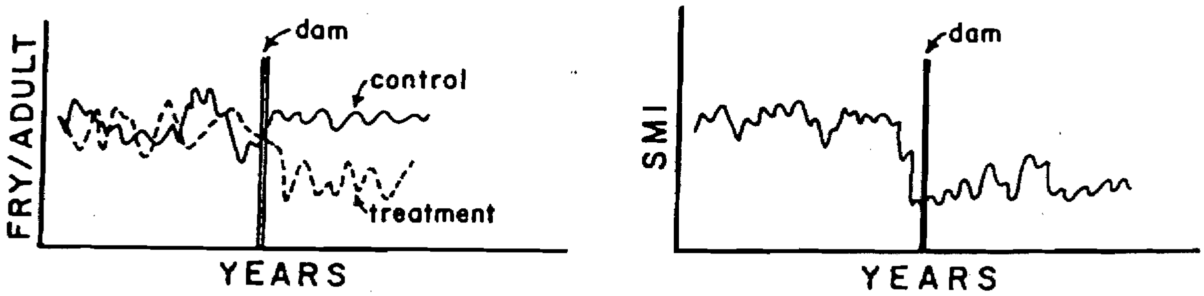

Figure 3. Time series plots of Fry/Adult Ratios and SMI's.

change in the treatment/control ratio is required before a change can be statistically detected? What this percentage is could easily be calculated before the fact if one knows the variance structure of the ratio. There is probably no good way to make this calculation until we have a number of years of data. We will have to calculate the index for several years and see how much it varies. If there is a large degree of variance between the years, the model will not accomplish the objective.

D. Assumptions The following are assumptions which to a greater or lesser degree need to be valid for the SMI approach for detecting impacts to work.

1. Salmon stocks in the Talkeetna and Chulitna rivers, and that portion of the Susitna River in the control are subject to the same natural variability as the treatment portion of the Susitna River.

2. The Cook Inlet commercial fishery does not selectively fish for any stock or species migrating above Sunshine Station (the control).

3. That adult fishwheel CPUE is primarily related to total escapement regardless of the extent of milling.

4. The peak of juvenile outmigration for all species occurs during the open-water period.

5. Smolt trap and fishwheel efficiency remains constant.

6. A change in the position of the fishwheels as a result of with-project flow will not adversely affect the efficiency of the wheels.

7. Any with-project change outside the natural variation of the ratio would be a dam-caused effect.

E. Problems Based on past observation, a number of potential problems have been identified which suggest that our model assumptions may be violated.

1. It is not likely that the control will be subject to exactly the same variability as the treatment.

   a. The control (Sunshine) is not a true control because it includes treatment effects. The Talkeetna River may be a better control and should be considered.

   b. The treatment and the control experience different and varying milling rates.

   c. Gear efficiency varies with discharge, debris loading, catch rates, etc.

2. Adult milling is not considered in the CPUE ratio equation.

3. The peak migration of chum and pink salmon may occur before it is physically possible to place outmigrant traps in the river (i.e., under the ice or with break-up).

4. The variance in the natural ratio may be so large it will be impossible to detect a with-project effect (until a catastrophic impact has occurred).

F. <u>Options/Alternatives</u> The following alternatives to the proposed SMI model are being considered:

1. Time series analysis where the natural variability at one site (Curry) is used for both the treatment and the control. This method has a problem where several years would pass before a change could be detected unless projected physical parameters regimes were linked to an index (survival, adult inmigration, juvenile outmigration) with a transfer function model.

2. Evaluate habitat for a specific life stage (for example, incubation) in conjunction with the adult inmigration and juvenile outmigration.

3. Use the Talkeetna River, Chulitna River, or both as the control site. The reason Sunshine Station was tentatively chosen was because five years of adult salmon inmigration has been collected at this site. However, collecting both juvenile outmigrant data and the adult data may be more feasible on the Talkeetna or Chulitna rivers.

G. Review Team Comments

The review team discussed the conceptual basis for a Survival Monitoring Index. Dana Schmidt, who had proposed the SMI approach when he was working on the Susitna Aquatic Studies Program, participated in the discussions. The team voiced strong support for conducting post-project habitat utilization monitoring in conjunction with population monitoring as a means to verify impact projections and the effectiveness of mitigation plans. Habitat monitoring objectives were not discussed by the review team in any detail; rather, it was decided that specific habitat monitoring needs would be addressed by the divisions as part of the Department's involvement in a mitigation plan for Susitna. There was general agreement about the importance of not relying on either habitat or population monitoring alone. The need for a unified departmental position on long-term monitoring was emphasized. It was recommended that the management divisions work closely with Habitat Division to develop the Department's position.

The team as a whole accepted the concept of using a project control that would not be affected by the construction and operation of the dam to monitor natural variations in salmon production. However, the review team strongly doubted the feasibility of successfully implementing the SMI approach given the difficulty of developing a sensitive indicator of change for four independent population parameters which individually are subject to large natural variations.

Rather than attempt to monitor environmental change with one all encompassing parameter, the proposed SMI, the team recommended employing a number of key parameters which could be evaluated independently as well as interrelated when appropriate. The reliability of using Sunshine Station as a control when the treatment reach (middle Susitna River) would be included as part of the control was also questioned. In

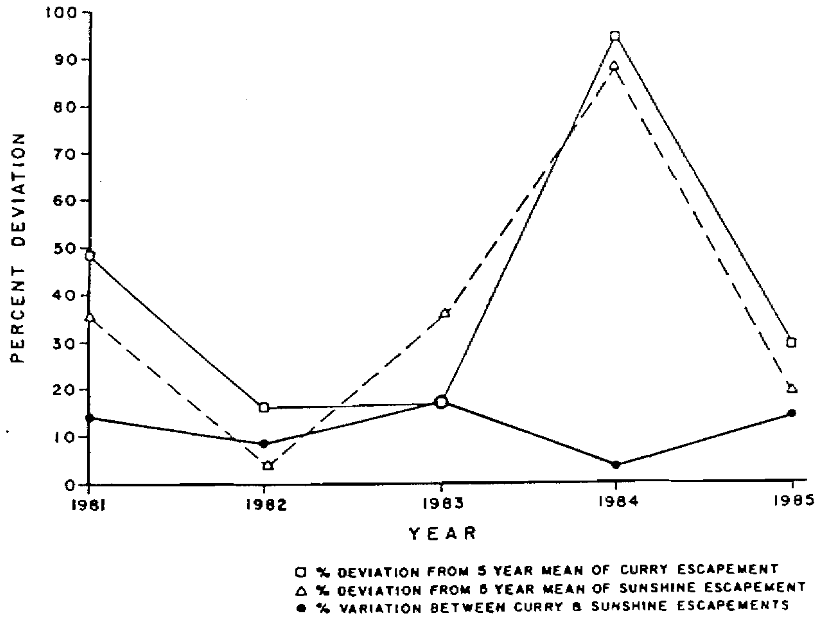

Figure 4. Annual variation in chum salmon escapement, percent variation from the five year mean.

addition, the team pointed out that the population levels being assessed at the proposed control are typically at least an order of magnitude greater than the proposed treatment site. Population size could have a significant effect on the ability of the proposed sampling gear to index the populations and hence influence sampling variance.

Dana Schmidt presented a comparison of chum salmon population escapement estimates for Sunshine Station and Curry Station for the five year period 1981-1985. The percent variation from the 5-year mean for both sites appeared to track reasonably well (Figure 4); however, a comparison for chinook salmon did not support the assumption that the control and treatment are subject to similar natural trends. Comparison of population estimates of juvenile salmon between the control and treatment was not possible because juvenile estimates have not been developed for a control site. Four years of juvenile population estimates are available for the treatment reach (Talkeetna Station site.)

It was pointed out that the proposed method of observing the variation in the SMI index over a period of years would just reflect inter-annual variation of its components and does very little to help determine how precise the SMI index may be. If an expression for the variance of the SMI index as it is related to its individual components is not derived the degree of change that can be detected (and is statistically significant) by it will not be known.

The use of an alternative site as a control was briefly discussed. The Talkeetna River has been considered in the past as an alternative study control. Collection of juvenile outmigrant data may be more feasible at a Talkeetna River site than at the Parks Highway crossing site near Sunshine Station. The longer width of the river and high water velocities at the

Parks Highway site significantly increases the difficulty and risk of operating juvenile inclined plane traps at this site. However, Sunshine Station has proven to be an excellent fishwheel capture site for adult salmon. The team did not make any recommendations concerning alternate sites other than emphasizing the need to maintain Sunshine Station for adult monitoring.

The use of CPUE data rather than population estimates for adults was not supported by the review team. Although correlation between CPUE for fishwheels and population estimates were reasonably high for some species; correlation based on only four data points was considered inconclusive. The teams also expressed concern about the highly variable catch efficiency of fishwheels. The wheels are moved periodically during the season because their catch efficiency varies with changing flows. Size selectively is also suspected for some fishwheels sites. Milling has been identified as a possible source of bias for fishwheels sites, especially the Curry site where milling has been observed during tag/recapture studies. Maintenance of constant catch efficiencies of fishwheels would be needed to appropriately employ a CPUE index; however, not only is maintenance of a constant efficiency impractical, measurement of efficiency is not possible without a independent estimates of population size.

Although sampling design problems associated with adult salmon populations estimates were identified (see discussion of population estimates above), these problems were considered solvable through time and size class stratification of tag deployment and a more random allocation of recapture effort. The population estimates were considered a much more reliable monitoring parameter then CPUE data. The spawning ground surveys which are used to recapture tags were also viewed as a valuable habitat utilization monitoring activity which should be continued. Pre- and post-project observations of stream life, distributional timing, and habitat use information obtained via the surveys may provide additional indicators of change caused by the dams.

Inclusion of juvenile outmigrant CPUE from inclined plane traps in the monitoring plan was discussed at length by the review team. Conceptually, the outmigrant component of the proposed SMI index should provide the most sensitive indicator of dam caused change on fresh water production. Monitoring of only adult salmon escapement has the risk of not accounting for differences in the saltwater life phase of the control and treatment populations. Some indication that treatment and control populations are not disproportionally affected during the ocean phase could be derived by monitoring and comparing timing, size, and age composition of returning adult stocks. An additional concern was that a dam-caused effect on freshwater production might not be observed until the adult population returned; a period of three to five years for some species could elapse before the problem could be detected.

The review team unanimously expressed their concern as to the feasibility of implementing a juvenile population index. Experience gained from work on monitoring juvenile salmon was shared and discussed. Most review team members had been associated with a juvenile monitoring program that had failed to meet its objectives. The high degree of difficulty associated with effectively sampling a juvenile population in large, complex systems where natural variations in time and space can be extremely large was stressed. The team agreed that at least four or five years of pre-project juvenile data would be needed to evaluate the relationship between control and treatment populations .

Another concern was that even if a post-project change in the SMI was statistically identified, could the change be attributed to a dam-caused effect. For example, if juvenile chinook salmon outmigration timing is influenced by flow, a post-project decrease in the annual CPUE index for juvenile chinook may not mean that their freshwater survival decreased. Under post-project regulated flows, a higher percent of rearing chinook may move out of the middle river prior to break-up and consequently would be missed by the sampling program.

The team outlined two possible courses of action to address concerns about long-term fisheries monitoring. These are stated as follows: 1) The Department and APA should agree as part of the settlement process that any change in fisheries parameters beyond established limits would be treated for mitigation purposes as a dam-caused impact and 2) a change in population indicators would serve as a signal that a problem may exist and detailed habitat assessment studies would be required to identify the cause. An impact mitigation policy that placed the burden of proof on the dam was favored. If a negative change is detected beyond negotiated limits, it would be assumed that the dam was responsible. The mitigation plan should also require that studies be initiated to identify the cause of the impact and to determine what specific mitigation actions are appropriate.

The use of CPUE data rather than juvenile population estimates was addressed by the team. Given the difficulty and expense associated with capturing and marking a sufficient number of juveniles to produce a reliable population estimate (approximately 250,000-500,000 marked chum would be needed for an estimate at Sunshine Station), the team suggested that a sample design employing mobile juvenile inclined plane traps be developed to address some of the obvious sources of temporal and spatial variance. In addition, the team felt that future juvenile monitoring work should concentrate on chum and chinook salmon. Most pink salmon outmigrate during break-up and before it is feasible to deploy the traps. Sockeye juveniles in the control and treatment reaches are not similar. Populations in the middle river spawn in side channel habitat and migrate downstream soon after emergence where as most sockeye outmigrating past the control station from the Talkeetna River are produced and rear in nursery lakes. The team did not recommend using juvenile coho salmon as a target species for monitoring environmental change. The highly variable nature of juvenile coho distribution would limit the probability of successfully detecting a dam-caused change.

The value of monitoring the total production capability of the Susitna River was discussed by the review team. It was suggested that continued monitoring of total salmon escapement into the River was important for stock management and also to provide a useful comparison of middle river salmon populations with the total production of the Susitna. The team felt that a comparison of this type might put the magnitude of dam-caused impacts on salmon resources into perspective. For example, how significant would a 50% reduction in sockeye salmon production in the middle river be without knowing that middle river production accounts for less than five percent of total Susitna sockeye. Conversely, the significance of a 50% reduction in king salmon production in the middle river would be evident if it represents 30% of the total production of the

Susitna. Also, monitoring total production of the Susitna would provide a very useful check on the long term health of the river. The possibility of joint funding of total enumeration studies on the Susitna by the Department and APA was also discussed.

III. Resident Fish Long-Term Monitoring

A. Problem Statement Hydroelectric development may alter the population structures of resident fish in the middle Susitna River reach. Natural conditions are characterized by low, clear winter flows and high turbid summer flows. With project conditions will be characterized by high, relatively turbid and warmer winter flows, delayed ice formation, and lower and clearer summer flows.

B. Objective Assess the positive and negative with-project effects on resident fish populations in the Susitna River by comparing pre- and post-project population abundance and distribution.

C. Procedures A continuation of the basic tasks now in place is proposed. The pre-project data will be compared to the post-project data. Changes will be documented and reported. The studies are geographically organized into pre- and post-project comparisons 1) below Devil Canyon and 2) the impoundment area.

1. Below Devil Canyon

(A) Pre-Project

(1) Continue to electrofish by boat at the 16 middle river index sites to make pre- and post-project comparisons in catch and CPUE. These sites are composed of three major habitats and comparisons of resident fish CPUE can also be made between macrohabitats.

(2) Continue to use secondary gear types such as gill nets and hook and line to supplement boat electrofishing data. Also, continue to record fishwheel and outmigrant resident fish catches.

(3) Continue to collect biological data from resident fish species to observe trends in age composition.

(4) Continue the tag/recapture program to generate population estimates and determine migrational patterns of selected resident fish species. Population estimates would be made for adult rainbow trout, Arctic grayling, burbot, round whitefish, and longnose sucker in the middle river. Population estimates will also be made separately for rainbow

trout in Fourth of July Creek. Fish movement data will be provided by analysis of tag recoveries. Species that will be tagged are rainbow trout, Arctic grayling, burbot, Dolly Varden, round and humpback whitefish, and longnose suckers.

(5) Every third year beginning in 1986, generate microhabitat suitability criteria curves to supplement microhabitat data gathered during previous years.

(B) Post-Project

(1) Continue boat electrofishing at middle river index sites and use of secondary gear types as described in the pre-project task.

(2) Continue to collect biological data as described in the pre-project task.

(3) Continue the tag/recapture program as described in the pre-project task.

(4) The radio telemetry program should be re-instituted for two years during construction and for at least three years after construction to provide better

movement data on middle river rainbow trout, Arctic grayling, and burbot.

(5) Microhabitat suitability criteria for adult middle river resident fish should be generated each year during construction and for at least two years after construction to determine how these fish have adapted to with-project changes.

2. <u>Impoundment Area</u>

(A) <u>Pre-Project</u>

Existing data collected over the last five years would serve as the pre-project data base.

(B) <u>Post-Project</u>

(1) Reinstitute the tag/recapture program during construction and continue the program for at least two years after construction to:

(a) generate population estimates for Arctic grayling, and

(b) determine movement patterns of selected fish species in the eight major clear water tributaries (i.e., Fourth of July Creek, Portage Creek).

Tagging and subsequent recapture of Arctic grayling should also be done in the upper reaches of Deadman Creek. This area has a much greater frequency of large Arctic grayling compared to other areas in the upper Susitna drainage. One access proposal to the dam site is the building of a road to Deadman Creek. Because of easier access, fishing pressure is expected to increase and thereby substantially alter the Arctic grayling population structure in what is now a "trophy" Arctic grayling area.

(2) Continue to collect biological data from resident fish to observe for trends in age structures.

(3) Radio tag Arctic grayling for at least two years to provide better information than gathered by tag recoveries on with-project Arctic grayling movement behavior.

D. Assumptions

1. Random mark-and-recapture effort.

2. Time between sampling does not affect recapture probabilities.

3. The population is closed geographically.

4. Gear efficiency varies with the size of fish.

5. There is a random mixing of tagged with untagged fish.

6. Mortalities due to capture and tagging are insignificant.

7. There is little difference in behavior between tagged and untagged fish.

8. The variability in sampling remains constant within and between years.

E. Review Team Comments

The review team was provided with a summary of data collection procedures, analysis, and results based on five years of resident fish species studies. Based on available data, resident fish populations other than burbot primarily use the mainstem Susitna River as a seasonal migration route between summer and winter rearing habitats; some use of the mainstem for overwintering rainbow occurs near the mouths of tributary streams. Populations of Arctic grayling and rainbow trout are small and presently may be relatively stable. It appeared that increased fishing pressure resulting from improved access and/or increased awareness of fisherman about the area may pose the largest threat to resident populations.

Due to difficulties in obtaining sufficient recaptures, past population estimates have not been very precise. Given a large variance associated with population estimates, the likelihood of detecting even major post-project changes in resident fish production appeared remote. It was also noted that radio tagged fish have been tracked in areas being electroshocked. When the generator was started, the radio monitored fish left the area immediately. If this avoidance of electroshocking occurs in the population in general, CPUE data collected by this method may be meaningless. The review team felt further mark-recapture studies for resident fish species may be unwarranted considering how imprecise past estimates have been, unless a feasible method of increasing tag recoveries could be developed that would produce population estimates with meaningful confidence intervals.

The team suggested several possible approaches to increase precision for resident fish populations without greatly increasing project costs. Options included increasing sampling effort by 1) reduction of species monitored to rainbow trout, Arctic grayling, and possibly burbot, 2) reduction of the number of fishing sites, and 3) a reduction of the frequency of surveys from annually to every two or three years. The team also recommended that one or two representative middle river monitoring areas (e.g., Fourth of July Creek and Portage Creek) be selected and that sampling effort should be concentrated on rainbow trout and Arctic grayling. The possibility of selecting a resident fish monitoring control area (e.g., Prairie Creek on the Talkeetna River) was also suggested.

Summary of Recommendations and Findings

1. The Department should develop a position on long-term monitoring. It was recommended that Commercial Fisheries, Sport Fisheries, and Game divisions should assist the Habitat Division in developing a comprehensive departmental position paper addressing Susitna long-term monitoring in the near future. The position should emphasize that a population based monitoring program should be initiated in FY87 and continued through construction and operation of a hydropower project on

the Susitna. In addition, regulatory monitoring and enforcement of mitigation measures (structual and operational requirements) as well as habitat utilization monitoring to assess the reliability of impact projections would be needed during construction and post-project. Details of what habitat monitoring might entail were not addressed. An interdivisional effort will be needed to detail the scope and components of a habitat/enforcemnt monitoring program in the near future so that both habitat and population monitoring programs can be intergrated.

2. As a whole, tag/recapture methodologies currently employed for Susitna stocks provide reasonably precise estimates (tight confidence limits) of salmon populations however accuracy of some of the estimates were questioned due to violation of assumptions used in developing Peterson estimates. Apparent discrepancies in adult sockeye salmon population estimates derived by hydroacoustic and tag/recapture methods may be explained and remedied by modification of the tag/recapture sampling design.

3. Sampling effort could be optimized and possibly reduced without a significant loss of precision in the estimate. This must be determined by an analysis of past years data.

4. A positive relationship between population estimates and cumulative seasonal CPUE from fishwheels catches based on a very

limited number of data points may exist for some species at some sampling locations; however, for other species this relationship can not be detected. Some of the assumptions implicit in the use of CPUE as an index of population change have not been tested and may not be valid. For example, possible within season and between season variability in gear efficiency is suspected. Insufficient data is available to evaluate a CPUE index for juvenile outmigrant populations for any species. No outmigrant data is available for Sunshine Station.

5. Based on the last five years of baseline data collection, natural variations associated with population estimates of adult and juvenile salmon populations utilizing the Susitna River are large and consequently detecting project induced effects on these populations would be very difficult unless these changes were of a large magnitude. The use of a control as a means to account for natural variation was supported.

It may be assumed, based on observations from past dam monitoring projects (the Libby Dam was specifically mentioned by Dana Schmidt), that changes resulting from hydroprojects were often large scale and detectable by conventional fisheries science methodologies. More subtle change probably can not be detected against the highly variable natural background of fish populations; state-of-the-art methods simply may not be sensitive enough to detect small scale impacts.

6. The use of juvenile chum and possibly chinook salmon outmigrant CPUE data in addition to adult salmon population estimates should be evaluated as long-term monitoring parameters. The relationship of adult salmon entering both the treatment and control reaches and the subsequent outmigration of juvenile salmon from these reaches should be monitored over at least a four-year period to determine if the assumption that treatment and control populations are influenced by similar environmental processes is valid.

7. Because the freshwater survival index approach to long-term monitoring is untested and a number of assumptions implicit in its application are considered highly questionable, the approach was not considered feasible. Alternative approaches for long-term monitoring should be identified and considered. Population parameters in addition to distribution and abundance such as age structure, condition factors, freshwater growth, and fecundity should continue to be collected during the pre-project phase of monitoring so that trends in these parameters for project treatment and control populations can be compared.

8. The precision of population data for resident fish species collected at established index sites should be improved to increase the probability that post-project changes in resident populations could be detected. A number of alternative methods for increasing precision were suggested and will be evaluated. It was also recommended that the effect of sport fishing on middle river resident fish populations be evaluated. Expansion of Sport Fisheries Division's creel and/or postal survey programs to include the growing middle river sport fishery was suggested.

9. The review team strongly recommend that the Susitna Aquatic Studies Program obtain biometric support and approval of all future work plans.

10. The team proposed the following priority (descending order) for long-term monitoring projects: 1) adult salmon monitoring, 2) juvenile salmon monitoring, 3) resident fish monitoring, and 4) water quality monitoring. It was suggested that the water quality monitoring program could be given to a consulting firm or USGS.

DEPARTMENT OF FISH AND GAME

SUSITNA HYDROELECTRIC PROJECT

Funding Provided by the Alaska Power Authority
Expenditures

DIVISION	78	79	80 (A)	81	82	83	Total 80/83	84	85	86 Authorized	TOTAL
Commercial Fish				$ 132,471.91	$ 619,940.97	$ 669,000.06	$ 1,421,412.94	$ 429,958.54	$ 900,072.55	$ 2,290,000.00	$ 5,041,444.03
Sport Fish				430,519.65	1,194,515.99	2,370,604.75	3,995,640.39	2,432,311.38	3,091,761.68	130,000.00	9,649,713.45
Total Fish				$ 562,991.56	$ 1,814,456.96	$ 3,039,604.81	$ 5,417,053.33	$ 2,862,269.92	$ 3,991,834.23	$ 2,420,000.00	$14,691,157.48
Game	$ 1,399.72	$ 15,100.25	$ 260,576.82	$ 648,789.46	$ 794,412.40	$ 1,093,815.18	$ 2,797,593.86	$ 927,499.70	$ 870,754.25	$ 495,000.00	$ 5,107,347.78
Habitat			8,532.31				N/A	$ 13,844.72	60,778.30	130,100.00	213,255.33
Total Ops.	$ 1,399.72	$ 15,100.25	$ 269,109.13	$ 1,211,781.02	$ 2,608,869.36	$ 4,133,419.99		$ 3,803,614.34	$ 4,923,366.78	$ 3,045,100.00	$20,011,760.59
Administration				$ 17,313.05	$ 33,286.95	$ 25,000.00	N/A	$ 25,813.88	$ 28,500.00	$ 20,000.00	$ 149,913.88
Total Dept.	$ 1,399.72	$ 15,100.25	$ 269,109.13	$ 1,229,094.07	$ 2,642,156.31	$ 4,158,419.99	N/A	$ 3,829,428.22	$ 4,951,866.78	$ 3,065,100.00	$20,161,674.47

(A) Game Division includes RS 08-8051 in the amount of $2,488.09

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