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Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife Part A: Rocky Mountains and Pacific Northwest **EXECUTIVE SUMMARY**



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ASSESSMENT OF EFFECTS OF ALTERED STREAM FLOW
CHARACTERISTICS ON FISH AND WILDLIFE
Part A: Rocky Mountains and Pacific Northwest

EXECUTIVE SUMMARY

By

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PREFACE

The U.S. Fish and Wildlife Service and the several State fish and wildlife agencies have, for a number of years, worked with construction agencies to recommend maintenance flow releases for fisheries below dams. However, these agencies typically have not had the resources available to determine whether the flows released, in fact, protected the fishery. It is to this objective that the project reported herein is directed.

This post-audit study examined flow conditions below 142 dams and diversions in California, the Pacific Northwest, and the Rocky Mountains. The California portion of the study was undertaken by Jones and Stokes, Inc., of Sacramento, California. The Pacific Northwest and Rocky Mountain regions were studied by Enviro Control, Incorporated, of Rockville, Maryland. Both firms were under contract to the U.S. Fish and Wildlife Service.

There are three kinds of reports available. Two executive summaries capsule the findings, conclusions, and recommendations in approximately 10 to 12 pages each. Three case study reports describe, for each dam or diversion, the instream flow recommendation and implementation activities. Two final reports contain an aggregate analysis of the instream flow recommendation and implementation activities for all of the dams and diversions in each region. In addition, they include the findings, conclusions, and recommendations resulting from the study.

This report is one of the seven. The titles, numbers, and availability of all of the reports in the series are identified below:

1. FWS/OBS-76/28

Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife

Part A: Rocky Mountains and Pacific Northwest

Executive Summary

- a. Inclusive States: Arizona, Colorado, Montana, Utah, Wyoming, Idaho, Oregon, and Washington
- b. Availability of the report: available on request from the Cooperative Instream Flow Service Group*

2. FWS/OBS-76/29

Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife

Part A: Rocky Mountains and Pacific Northwest

Final Report

- a. Inclusive States: Arizona, Colorado, Montana, Utah, Wyoming, Idaho, Oregon, and Washington.
- b. Availability of the report: available on request from the Cooperative Instream Flow Service Group, and from NTIS** (refer to No. PB263470/AS) at a charge of \$6.00 for paper copy.

3. FWS/OBS-76/30

Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife

Part A: Rocky Mountains and Pacific Northwest

Rocky Mountain Region Case Studies

- a. Inclusive States: Arizona, Colorado, Montana, Utah, and Wyoming.
- b. Availability of the report: because of its length, this report has not been widely distributed. Single copies have been sent to each of the Fish and Wildlife Service Area Offices in the inclusive States, to the State fish and wildlife departments, and to selected libraries within the region. Copies may be ordered from NTIS** (refer to No. PB 263471/AS) at a charge of \$10.50 for paper copy.

4. FWS/OBS-76/31

Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife

Part A: Rocky Mountains and Pacific Northwest

Pacific Northwest Region Case Studies

- a. Inclusive States: Idaho, Oregon, and Washington
- b. Availability of the report: because of its length, this report has not been widely distributed. Single copies have been sent to each of the Fish and Wildlife Service Area Offices in the inclusive States, to the State fish and wildlife departments, and to selected libraries in the region. Copies may be ordered from NTIS** (refer to No. PB263472/AS) at a charge of \$11.00 for paper copy.

5. FWS/OBS-76/32

Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife

Part B: California

Executive Summary

- a. Inclusive State: California
- b. Availability of the report: copies are available on request from the Cooperative Instream Flow Service Group.*

6. FWS/OBS-76/33

Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife

Part B: California

Final Report

- a. Inclusive State: California
- b. Availability of the report: the report is available on request from the Cooperative Instream Flow Service Group,* and from NTIS** (refer to No. PB263245/AS) at a charge of \$4.50 for paper copy.

7. FWS/OBS-76-34

Assessment of Effects of Altered Stream Flow Characteristics on Fish
and Wildlife

Part B: California

Case Studies

- a. Inclusive State: California.
- b. Availability of the Report: because of its length, this report has not been distributed widely. It has been made available to the Fish and Wildlife Service Area Offices in California, the Central Office and the Regional Offices of the State Department of Fish and Game, and to selected libraries within the State. It can be obtained from NTIS (refer No. PB 263246/AS) at a charge of \$16.25 for paper copy.

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FORWARD

This research effort focuses on an ex post evaluation of instream flow methodologies and the associated recommendation process to preserve fish and wildlife through instream flow reservations. Governmental decision makers have tended to accept ex ante analysis without an adequate inspection of the "track record" of such analysis. According to Robert H. Haveman, "...improvement in public sector performance will not be achieved unless information on the input (cost) and output (benefit) results of ongoing and completed government undertakings is incorporated into the decision process..."¹ Decision makers in fish and game agencies have not gathered the retrospective information so essential to improving instream flow methodologies and procedures. The failure to obtain this information stems from the constant pressure to give priority to ongoing and new projects. Therefore, ex post analyses are needed to provide decision makers with feedback on the consequences of previous decisions.

The U.S. Fish and Wildlife Service recognized this need and authorized ENVIRO CONTROL, INC. to conduct a series of case studies designed to evaluate the application and soundness of methodologies for predicting the impacts of water resource projects on fish and wildlife, as well as assessing the actual impacts on these biota. There has been no single publication or series of documents adequately dealing with these problems.

This document summarizes the Task 3 report (published under separate cover) which addresses the collective case study findings covering 109 instream flows distributed in nine western states. The report also provides the detailed summary and evaluation of the findings, and a series of recommendations to help remedy the identified problems. This summary of the Task 3 report consists of three sections. The introductory discussion explains the background, purpose, and methodology of the research. The more significant conclusions derived from the study are summarized in the next section. These conclusions are utilized in the final section as the basis for key recommendations for improving the process of instream flow reservation and implementation. Readers seeking greater detail in the findings or the rationale for the recommendations are urged to obtain the full Task 3 report. If even further amplification is required, the separate case studies themselves should be inspected.

¹Robert Haveman, The Economic Performance of Public Investment, An Ex Post Evaluation of Water Resources Investments (Baltimore: The Johns Hopkins Press, 1972), p. 2.

The effort covered by this study was contributed by R. Wayne Nelson, Gerald C. Horak, Martin H. Lewis, and Joanne S. Colt, assisted by Arthur S. Hale, Edward G. Hoban, David H. Wagaman, Zell E. Parkhurst, and G. Bradford Shea, under the direction of R. Wayne Nelson. Constructive review was provided by Dr. John F. Orsborn of Washington State University and Milo C. Bell of the University of Washington. Dr. Harvey R. Doerksen and Robert P. Hayden of the Western Water Allocation Project, Office of Biological Services, U.S. Fish and Wildlife Service, provided research guidance and review, assisted by Austin K. Andrews, Robert Cleary, and Joseph W. Kathrein.

The researchers are indebted to the countless agency representatives and others whose cooperation was extraordinary during the sometimes vexing and always tedious task of extracting and compiling detailed historical information. We owe special gratitude to Anita L. Calcote for her conscientious editing and typing of the voluminous case studies.

TABLE OF CONTENTS

	<u>Page</u>
PREFACE	iii
FORWARD	vii
I. INTRODUCTION	1
A. Background of the Research	1
B. Purpose of the Research	2
C. Selection of Instream Flows/Task 1	3
D. Performance of Case Studies/Task 2	3
E. Analysis and Summary of Findings/Task 3	4
II. SUMMARY AND CONCLUSIONS	5
A. Overivew	6
B. Formulation	6
C. Bargaining	7
D. Implementation	9
III. RECOMMENDATIONS	11
A. Recommendation Process	12
B. Monitoring System	13
C. Agency Re-Direction	14

I. INTRODUCTION

In this introductory discussion, five topics are addressed for the purpose of reader orientation to the:

- Background of the research
- Purpose of the research
- Selection of instream flows (Task 1)
- Performance of case studies (Task 2)
- Analysis of case study findings (Task 3)

A. BACKGROUND OF THE RESEARCH

Water resource projects are designed to serve a variety of purposes including flood control, navigation, power generation, irrigation, industrial and municipal water supply, recreation, and the preservation and propagation of fish and wildlife. Not all of these purposes are served equally well by a particular project, causing disputes among groups espousing various purposes. Mindful that economic interests generally prevail over unpriced social welfare, the U.S. Congress enacted a series of laws that eventually established the Fish and Wildlife Service and formalized the nation's concern for the conservation and development of fish and wildlife resources, especially in connection with water resource development projects.

The associated responsibilities of the Fish and Wildlife Service (FWS) under the Fish and Wildlife Coordination Act are to:

- Investigate and report on water resource development projects prior to their construction or license by the Federal government
- Determine the probable effects of such projects on fish and wildlife resources and associated habitats
- Recommend measures for preventing or reducing damages to and improving conditions for these resources.

To improve the methodological tools the FWS uses to discharge its responsibilities, it has been necessary to conduct a sequence of case studies designed to assess the prevalence and effectiveness of methodologies for predicting the impact of water resource projects on fish and wildlife, as well as the historical impact on these fauna. This had been achieved

to a limited extent by an earlier study of Bureau of Reclamation projects, entitled "Ex Post Evaluation of Fish and Wildlife Mitigation," performed for the Bureau of Sport Fisheries and Wildlife in 1973.

B. PURPOSE OF THE RESEARCH

The present study is one of several allied activities of the FWS Western Water Allocation Project under the management of the Western Energy and Land Use Team.

An overall goal of this project is to maximize consideration of fish and wildlife in water allocation decisions, particularly those that relate to energy development. A major thrust of the water allocation program at the present time is that of developing methodologies to preserve instream flows for fish and wildlife. Several projects are currently directed to this goal, by reviewing and analyzing methods for assessing instream flow requirements of fish and wildlife, evaluating the success of instream flow needs methodologies which have been used in the past, co-sponsoring an instream flow symposium, and sponsoring a center to provide service to field personnel who make instream flow recommendations.

The purpose of this particular research is to develop recommendations on improving methodologies for determining instream flow requirements for fish and wildlife. The specific objectives designed to fulfill this purpose are:

- To determine the actual effects of altered flow characteristics on fish and wildlife downstream from a number of dams and diversions
- To determine the degree to which the various methodologies used were successful in predicting these effects and the instream flow requirements for fish and wildlife
- To identify biological and non-biological constraints on the success of these methodologies and the project evaluation processes.

These objectives were accomplished in three major tasks:

- Selection of candidate projects and flows for case study analysis
- Performance of case study interviews and evaluations
- Development of recommendations based on case study findings.

C. SELECTION OF INSTREAM FLOWS/TASK 1

The objective of the first task was to select a representative sample of at least 30 water resource projects involving 50 to 100 instream flows for in-depth case studies in both the Rocky Mountain and the Pacific Northwest regions. The identification of candidate projects relied on several principal sources:

- All dams and major diversions appearing on the Water Resources Development Map of the U.S. Water Resources Council
- Reference documents on project status such as the Bureau of Reclamation's "Active Names of Bureau Projects and Major Structures" and the FWS KEYSORT project summary system
- Interviews and a files search with personnel of the Division of Ecological Services and the Office of Biological Services in central, regional and field offices.

By applying selection criteria covering project operating status and recorded instream flow recommendations, over 100 candidate projects were identified. To ensure representativeness of projects in terms of distribution by state and region, by biotic and abiotic environment, by main project purposes, and by sponsoring or permit agency, the FWS used a random sampling technique to determine those projects on which case studies would be conducted in Task 2.

D. PERFORMANCE OF CASE STUDIES/TASK 2

The objective of Task 2 was to conduct case studies to determine:

- Whether the original project plan for altering the stream-flow regime was followed
- The extent of investigations and the methodologies used to predict biological effects and to determine instream flow requirements
- The comparative biological and hydrological pre- and post-project conditions and the actual effects of the altered flow characteristics on downstream fish and wildlife
- The relevancy and effectiveness of the methodologies used in ensuring the project's compatibility with fish and wildlife resources.

Case studies were conducted on 109 instream flows involving 78 water resource projects in nine western states. In the Pacific Northwest region (Idaho, Oregon, and Washington), 53 instream flows were studied; 56 flows were examined in the Rocky Mountain region (Arizona, Colorado, Montana, New Mexico, Utah, and Wyoming). Each case study involved extensive review of fish and wildlife and sponsoring agencies' records, in-depth interviews of the respective agencies' personnel, and a review of USGS, project sponsor's, and/or State Engineer's hydrologic records. This effort was aided by the development of a questionnaire and interview guide designed to ensure consistency in the type and amount of information collected for each case.

E. ANALYSIS AND SUMMARY OF FINDINGS/TASK 3

Task 3 was directed to the following objectives:

- Analyze, evaluate and summarize the success and effectiveness of the biological investigations, project evaluation processes, and institutional arrangements reviewed during the individual case studies
- Identify problems, constraints on success, and opportunities common to habitat types, project purposes, sponsoring organizations, and methodologies
- Recommend procedures which will improve instream flow methodologies and project evaluation processes, and which will guarantee the compatibility of both existing and future water development projects with fish and wildlife resources.

The report on Task 3 proceeds in a sequence of separate chapters on collective case study findings, detailed evaluation of the findings, conclusions and summary, and a series of recommendations to help remedy the identified problems.

The methodology utilized in evaluating and summarizing the findings of the 95 case studies covering 109 instream flows is briefly described. The case studies were used to identify and compile characteristics common to all projects such as location and physical setting, the four modes of success evident for each instream flow, and the various hydrological, biological, legal, institutional and methodological constraints upon instream flow success in selected cases. The four modes of success were identified as success at bargaining, flow implementation, fishery preservation, and predicting instream flow needs and effects.

To facilitate this case study evaluation, a case study analysis notebook was developed which contained a two-page summarization of pro-

ject characteristics and factors influencing the outcome of the instream flow process as applied to that project. This notebook was helpful in isolating the operative constraints and associated characteristics in each case, and was the basis for the compilation of aggregated findings. The notebook summary for each flow also identified the level of documentation of the available information.

The average and low flow hydrographs displayed in the case studies were also employed in the evaluation. These graphs were used to characterize both the pre-project flow regime and the relative success at flow implementation during project operation. In determining flow implementation success, the USGS Daily Value Statistical Program A969 was utilized. This program revealed, among other things, the severity of flow deficiencies and violations of inter-agency flow agreements.

Case history diagrams, which were developed as a tool to summarize findings on bargaining, were also applied in the evaluation process. The diagrams identified the amount, timing and outcome of each instream flow request, and were used to discern distinct patterns of bargaining failure and success.

The chapter on the evaluation of the case study findings is essentially a matrix analysis. Series of tables are presented which report the frequency of association a particular constraint or set of constraints has with the four modes of project success. These multiple associations are made to determine which factors may be influential in achieving success. Where a certain factor is found to be a possible significant influence on success due to a high association, an analysis follows to explain how this constraint may operate.

The evaluation section concludes with a specialized matrix analysis which includes fewer cases than considered in the basic evaluation tables. It only employs decisive or documented findings while the many tables associating constraints with success incorporate nearly all the significant findings, the majority of which were derived judgmentally. The specialized matrices, therefore, serve as a confidence test of the findings disclosed in the previous tables.

II. SUMMARY AND CONCLUSIONS

This section summarizes the more significant conclusions derived from the case study findings. The summary is organized into four subsections:

- Overview
- Formulation
- Bargaining
- Implementation

The major conclusions outlined here have been used to develop key recommendations for improving the instream flow process.

A. OVERVIEW

In the two regions combined, there was outright failure at predicting fishery effects and requirements and in bargaining for flow reservations for roughly one-fifth of total flows. In contrast, for about two-fifths of all flows, there was marked failure to obtain the adopted instream flows and to maintain the fisheries. It does not seem surprising that planning success should generally be double the success at implementation, but a much greater effort at monitoring and enforcement does seem indicated. At this point in time, it appears that relatively more benefits could accrue from a concerted enforcement effort than from improved methodology and procedure, although it is obvious that both are imperative.

Several inter-regional distinctions are noticeable in the summary distribution of the four modes of success; while bargaining success was significantly better in the Pacific Northwest, project flows incurring violations were three times more frequent and fishery deterioration was reported more than twice as often. Adoption of generally greater flows in the northwest tends to explain the greater occurrence of violations, and more fishery losses may occur due to generally greater flow requirements of the anadromous fisheries there.

B. FORMULATION

Formulation of flow requests involves the methodologies utilized in predicting instream flow needs and effects. Significant findings and constraints on predictive success are presented here.

Hydrological and biological field observation and estimation are almost always used, as distinguished from "office studies". Conversely, hydrological and biological investigations rarely entail field measurements, although gauging records were utilized in over half of the hydrological investigations. However, follow-up investigations employed more detailed hydrological and biological techniques.

The biological objectives of minimum flow recommendations have been to maintain rather than augment or enhance stream fisheries. This objec-

tive has been achieved by prescribing preservation of stream fishery or waterfowl habitats, and is rarely directed at population classes or life cycles.

In formulating the initial flow request, the costlier, more detailed and quantitative methodologies have been used sparingly. However, estimation of biotic and abiotic habitat parameters and incremental analysis of biological effects for a range of flows were almost always used to formulate follow-up requests.

Since the late fifties, field observation, analysis of streamflow records, and professional judgment have been the dominant techniques in formulating instream flow requests. During this period, reliance on methodologies employing habitat criteria and streamflow records increased. Dependence on costlier, more detailed transect and incremental analysis techniques having higher rates of predictive success has declined over time. They have been replaced by techniques using stream gauging data and selective habitat parameters, associated with lower rates of success.

C. BARGAINING

To summarize the significant findings and constraints on bargaining, this subsection has been subdivided three ways:

- Offer of recommendations
- Response to recommendations
- Other important factors.

The first category embraces factors which are controlled by the fish and game agencies, such as the timing or amount of their recommendations. The second covers influences which pertain to the sponsor agency, such as project purposes. The third category includes constraints such as water rights which impact upon the bargaining process, but do not originate with either the recommending or responding parties.

1. Offer of Recommendations

Most flow requests have resulted in a flow reservation; however, only a little over half of the requests have obtained outright acceptance without some modification. While less detailed methodologies have promoted more chance of acceptance, more detailed methodologies have increased chances of a modified flow amount. Correspondingly, less demanding biological objectives have obtained more reservations of minimum flow.

Timing and amount of requested instream flows had significant effects on bargaining. Flow requests made after the project began operating usually resulted in poor bargaining success. Requests for smaller amounts of minimum flow have improved the chance of acceptance.

Certain forms of flow requests such as "outflow-equal-to-inflow" and seasonal flows have contributed to favorable bargaining. The "outflow-equal-to inflow" recommendations were accepted almost twice as often as all flow requests. Requests for a seasonal flow regime were always accepted -- with or without modification.

2. Response to Recommendations

Sponsoring and permit agencies can have considerable influence on bargaining. Bureau of Reclamation-sponsored projects have been linked with poor bargaining success and frequent modification of requested flow amounts. Bargaining success generally transpired with projects authorized by the Bureau of Land Management or a state permit agency.

Additionally, the kind of project purpose can influence bargaining. Flow requests for irrigation projects incurred more rejections than the norm. Successful bargaining was recorded for both recreation and water supply projects.

3. Other Important Factors

Legal and administrative influences on bargaining yielded three important conclusions. First, downstream water rights were an influence (both positive and negative) in bargaining for instream flows. Secondly, better bargaining success was evident for flows requested after the Fish and Wildlife Coordination Act was legislated. Finally, renewal of an FPC license or the re-negotiation of a reservoir storage contract provided an opportunity for the FWS to enter the bargaining process.

Two other factors affecting bargaining, and related to recreation and fishing, are:

- When reservoir fishing and recreation interests were strong, bargaining for instream flows tended to be replaced by efforts to assure a minimum reservoir pool
- Availability of fishery stocking as a mitigative measure has deterred the adoption of minimum instream flows.

D. IMPLEMENTATION

This summary and conclusions on implementation of instream flow recommendations has two basic divisions: implementation of requested flows; preservation of fish and wildlife. Implementation of flows encompasses the fulfillment of requests never adopted as well as compliance with flow reservations.

1. Implementation of Requested Flows

Hydrologic data adequate to document compliance with both requested and reserved flows were available for approximately half of the flows studied. Compliance with flow recommendation and reservation provisions such as "instantaneous flow" and "maximum rate of flow alteration" could not be documented because adequate hydrologic data were unavailable.

Instream flows were estimated to be deficient in nearly half of the cases studied, and where the extent of fulfillment of flow requests could be documented, flows were deficient in over half of the projects. These flows have been deficient, on the average, for 64 days out of a year; nearly twice a year, on the average, the mean monthly flow was below the requested minimum level of flow. Also, on the average, the requested level of minimum flow approximated the average 7-day low flow (i.e., threshold level of severe stress on the fishery).

Three factors were related to fulfillment of flow requests:

- Availability of fishery stocking as a mitigative measure deterred the implementation of instream flow requests
- Exporting water from a reservoir has had a deleterious effect on instream flow implementation
- Water appropriation rights occasionally impeded or assisted the implementation of requested flows (and reserved flows).

Reserved instream flows were almost always reported to be maintained at levels agreed to; however, where these flows could be documented, they were maintained less frequently. For documented flows, flow agreements were violated, on the average, 29 days per year, and the monthly mean was less than the level of the reserved minimum flow once a year on the average. In documented cases where instream flows were reserved, their average reserved amount was only half of the average 7-day low flow.

Follow-up studies to check compliance with instream flow reservations have been infrequent. However, where stream gauge records were monitored by an outside agency, there usually was compliance.

Flows associated with either irrigation projects or projects sponsored by the Bureau of Reclamation generally have involved poor implementation success. On the other hand, water supply and recreation projects generally were associated with successful instream flow implementation. Additionally, projects authorized under a state permit system usually produced a high level of compliance with both requested and reserved minimum flows.

The relative yield of watershed precipitation had considerable impact as to the implementation of flow requests and reservations. At times a reduced watershed yield was a severe constraint; conversely, increased post-project watershed yields have promoted implementation. Dam seepage and spills often aided the provision of minimum flows, especially where streamflows were small.

Among other factors influencing implementation, less demanding biological objectives enabled greater compliance with both requested and reserved flows. Likewise, better implementation of flow requests and reservations resulted after the enactment of the Fish and Wildlife Coordination Act (1958).

2. Preservation of Fish and Wildlife

Most fish and wildlife habitats have been maintained, although population curtailments sometimes were significant, especially when stress on the fishery increased due to decreased low flows. Hydroelectric projects were frequently associated with a deteriorated stream fishery. Fisheries were generally preserved in projects authorized by a state permit agency. Fishery maintenance was improved for flows requested after the Fish and Wildlife Coordination Act was legislated.

Certain management practices have had considerable impact on stream fisheries preservation. Hatchery production and fishery stocking have been moderately effective mitigative measures for population maintenance of resident fish species. However, where a dam imposed a major spawning barrier to anadromous fish species, fish passage facilities were far more effective for preserving a fishery than was stocking.

The following four influences were among those adverse to fishery preservation:

- Flood flows or very high-velocity streamflows have sometimes offset the fishery benefits of low flow maintenance
- Reduced watershed yield was a severe constraint upon fishery preservation
- Exporting water from a river basin has hampered fishery preservation, especially when streamflows were lowest
- Increased post-project flow fluctuations, such as occur with hydroelectric power generation, were associated with substantial fishery deterioration, even where minimum flows were maintained.

Hydrological and biological constraints on preserving stream fisheries had considerable impact. Hydrological influences, such as substantial post-project equalization of flows throughout the year, spring and tributary inflow below a dam, dam seepage and spills, and increased watershed yields have, on occasion, promoted fishery preservation despite poor flow implementation. Beneficial habitat influences have included deep streambed pools (often not observed during field investigations), which have sometimes provided sufficient habitat for fish survival where streamflows were extremely low or non-existent. Also, where a minimum reservoir pool has been reserved instead of an instream flow, some downstream fisheries were maintained as a result of stocking the reservoir and other reservoir effects such as sediment retention. Finally, post-project improvements in stream temperature, turbidity, and chemical water quality frequently offset potentially adverse effects associated with deficient instream flows.

III. RECOMMENDATIONS

The more important recommendations flowing from the aggregate findings derived from case studies are highlighted in two major sections:

- Instream flow recommendation process
- Instream flow monitoring system.

The first set of recommendations are concerned with how the flow requests are formulated and expressed; the latter group deals with how the reserved flows can be watched and maintained more effectively. Each of these sections considers both immediate remedies -- means and measures which can be implemented reasonably in the near future, and long-term remedies -- means and measures to be implemented at a later time because of high cost or manpower requirements.

A. RECOMMENDATION PROCESS

Important immediate remedies are believed to include four steps. First, when formulating instream flow recommendations, determine the availability of hydrologic information so that flow provisions can be attuned to the locations and features of existing streamflow gauging stations or other monitoring devices, and new stations or devices may be proposed in the flow request as a project cost. Next, include as part of the recommendation that if it is modified by the sponsor agency, such as inserting an "outflow-equal-to-inflow" provision, adequate gauging devices be installed to meet the monitoring requirements of the modified flow reservation. Also, when requesting instream flows, specify the exact stream reach to which the flows are meant to apply. Finally, review the water rights situation affecting the concerned stream reach, and tie the requested flows to the amounts appropriated in various segments of the reach.

Significant long-term remedies are presented in the areas of project intelligence, instream flow methodology, and project reassessment. An active and integrated intelligence system should be developed to identify projects in the planning stage, especially those in five categories:

- Forest Service permit applications
- Bureau of Land Management permit applications
- Federal Power Commission license renewals
- Bureau of Reclamation repayment renegotiations
- State permit applications.

Methodological improvements are suggested in the areas of data standardization, cost-effectiveness studies, and incremental flow requests. Some standardization in biological and hydrological parameters of water quality and quantity used to formulate requests should be created so that methodologies would be comparable and a post-project follow-up evaluation can be achieved using the same parameters. The recommendation process can be greatly enhanced and made more defensible if each state were to analyze entire river basins to determine biological and hydrological baseline values. These state studies could be coordinated by some appropriate Federal agency (e.g., Fish and Wildlife Service or Water Resources Council). Once these studies were available, the recommendations of Federal and state fish and game agencies on a specific project could be simplified and made more consistent due to the existence of common baseline data.

Controlled before-and-after studies which employ alternative techniques should be carried out selectively to determine which methodologies are most ecologically sound and cost effective for a given size and type of stream and stream fishery. Requests should be formulated which contain several graduated levels of flow and the corresponding altered

flow characteristics and biological effects ranging from minimum to optimum conditions for fish and wildlife habitats. These should cite the additional measures such as fishery stocking and building of fishways that would be required to maintain the stream fishery at each level of flow, including the associated fish and wildlife benefits or losses.

Projects now in planning and construction should be reassessed to establish whether instream flows were recommended and reserved, and their adequacy; possibly a revised flow regime and necessary monitoring devices should be recommended. Also, these projects together with projects in operation should be reassessed to determine where instream flows might be augmented due to the availability of unallocated reservoir storage.

B. MONITORING SYSTEM

Monitoring remedies having more immediate potential concerning gauged and ungauged streams are discussed. On gauged streams, records provided by operating agencies should be routinely checked to ascertain compliance with the flow reservation. If flows are in violation of inter-agency agreements or regulatory requirements, the dam operator or operating agency should be contacted to determine mitigating circumstances, if any, and to obtain compliance. If violations persist, evidence should be taken to FWS supervisors to support funding of a detailed follow-up study or other appropriate action. Most importantly, a list of reserved and preferred instream flows should be published and provided to all concerned parties such as dam operators, operating and regulatory agencies, state fish and game departments, and environmental organizations. On ungauged streams, the help of environmental organizations and state fish and game departments should be enlisted in monitoring these streams.

A number of long-term remedies are recommended for consideration. A system should be developed permitting the FWS to access USGS computer files (Reston, regional, and state offices) of streamflow and water quality data to determine whether reserved or recommended flows are maintained. Regional FWS offices should be informed of violations so they can proceed with steps outlined under immediate remedies. Also, a system should be developed which would compile records on altered flow characteristics such as the rate and degree of flow fluctuation, as the USGS currently provides for daily average discharge.

Each year a document should be published which cites and verifies the worst violations of instream flow agreements or stipulations, including an estimate of biological effects and any mitigating circumstances preventing compliance. The document should also highlight instances of dramatic improvement in compliance.

When sustained violations of flow reservations occur, any recourse the FWS, states, environmental organizations, and citizens may have to remedy the situation and receive compensation for losses incurred under the Fish and Wildlife Coordination Act, National Environmental Policy Act, Endangered Species Act, Federal Water Pollution Control Act Amendments, and administrative actions such as FPC, BLM, Forest Service and State Engineer licenses or permits for water resource development projects should be investigated.

Stream reaches where flows are already reserved should be investigated to determine the priorities for installing monitoring devices. Once priorities are set, monitoring devices should be installed in critical stream segments, possibly funding this program through agencies or permittees benefitting most from water uses adverse to fish and wildlife.

Finally, a comprehensive program should be developed utilizing the FWS KEYSORT, Wyoming Master Statewide Project Index, or similar system which follows the progress of projects concerning the status of instream flows.

C. AGENCY RE-DIRECTION

The proposed remedies would place minimal additional burden on the fish and game agencies' work force or funds. What is suggested instead is a re-direction of agency efforts, presently concentrated in the initial review and evaluation of instream flow requests, towards performance on a continuous basis by emphasizing greater ongoing vigilance through follow-up studies and routine monitoring and enforcement. This re-direction would provide incentives to fish and wildlife agencies and to sponsoring and permit agencies to assume their respective responsibilities regarding instream flows. The fish and wildlife agencies' incentive would flow from the realization that by concentrating part of their efforts on monitoring the implementation of existing and future instream flow agreements, fish and wildlife resources would be better preserved or enhanced. Conversely, construction and permit agencies would be cognizant that receiving unfavorable recognition of broken agreements could adversely affect their program funding and they would be more inclined to maintain the instream flows agreed to.

BIBLIOGRAPHIC DATA SHEET		1. Report No. FWS/OBS - 76/28	2.	3. Recipient's Accession No. see item 18 below*	
4. Title and Subtitle Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife Part A: Rocky Mountains and Pacific Northwest Executive Summary		5. Report Date August, 1976		6.	
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16. Abstracts This report contains the findings, conclusions and recommendations regarding changed flow regions below dams, the impact on fisheries and methodologies used to assess flow requirements for 96 dams and diversions in the Rocky Mountain and Pacific Northwest regions.					
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