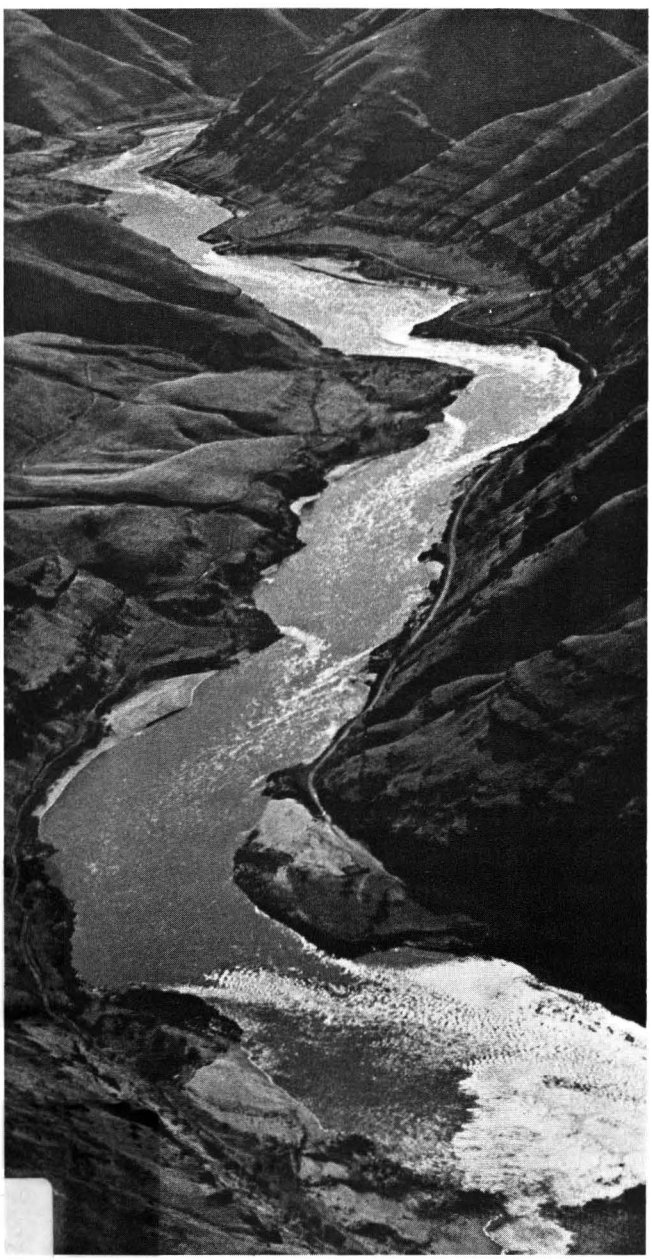
Biological Services Program

August 1977

FWS/OBS—#77/36



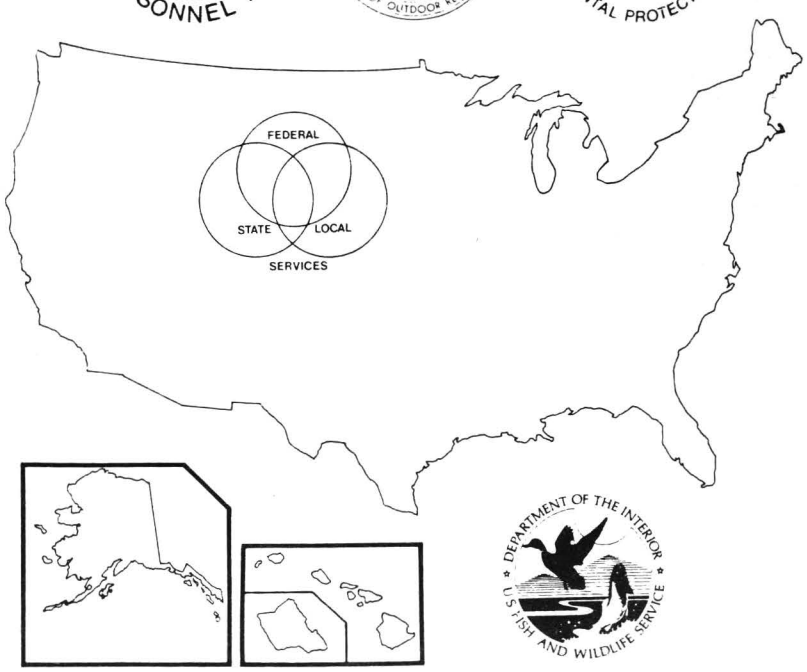
Cooperative Instream Flow Service Group

THE FIRST YEAR

FISH AND WILDLIFE SERVICE

U.S. DEPARTMENT OF THE INTERIOR

Techniques for assessing the biological and recreational impacts of low flows at existing and future energy installations—including new oil shale and coal technologies—are under development by the Instream Flow Group.



COOPERATIVE INSTREAM FLOW SERVICE GROUP

The Cooperative Instream Flow Service Group was formed in 1976 under the sponsorship of the U.S. Fish and Wildlife Service. Primary funding was provided by the U.S. Environmental Protection Agency. The group operates as a satellite of the Western Energy and Land Use Team. It is a part of the Western Water Allocation Project, Office of Biological Services.

Cooperative Instream Flow
Service Group
333 West Drake Road
Fort Collins, Colorado 80521
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While the Fish and Wildlife Service is providing the initiative and leadership, the IFG is conceived as a multi-agency, multi-disciplinary program which is to become a "center of activity," providing a focus for the increasing importance of instream flow assessments.

The multi-agency, multi-disciplinary nature of the group is provided through the Intergovernmental Personnel Act transfer of state personnel, and details from other Federal agencies.

Interagency Energy-Environment
Research and Development Program
Office of Research and Development
U.S. Environmental Protection Agency

"...timely, accurate information (is needed) about the effects of resource development upon fish and wildlife resources and their supporting ecosystems. This information is intended not only to assist planners in Federal , State, and local governments and the private sector, but also to keep the American public fully aware of the stakes involved in decisions affecting their environment."

Lynn A. Greenwalt, Director U.S. Fish and Wildlife Service

INTRODUCTION

To pass from a state of resource abundance to a condition of resource scarcity can be a severe experience for an individual biological organism—and for a nation as well.

Yet this is where the United States finds itself toward the end of the 1970's. Many resources, once thought to be in ample supply, are proving to be finite in scope and/or availability.

Energy and water are among the most vital of these shrinking resources. Both are necessary to the economic and environmental health of the nation, and limitations on their availability will impact the lives of all.

To complicate the situation, the uses of energy and water are closely interrelated. One cannot be considered without the other and the most careful planning of their utilization will be needed.

To meet these planning needs, information must be made available to the nation's decision-makers on how the allocation of water supplies for instream vs. out-of-stream uses will affect the aquatic environment and the riparian landscape. Information is needed to allocate wisely the limited water resources of certain regions and to determine where new energy technology installations and irrigation developments might be sited with the least adverse impact.

It is in this area of information development, synthesis, and dissemination that the Cooperative Instream Flow Service Group (IFG) is functioning. The IFG was established in July 1976 as a satellite group of the Western Energy and Land Use Team, Office of Biological Services, U.S. Fish and Wildlife Service. Funds for the support of the IFG have been furnished by the U.S. Environmental Protection Agency and the Water Resources Council.

Although organizationally linked to the U.S. Fish and Wildlife Service as part of the Western Water Allocation Project, the Instream Flow Group, located at Fort Collins, Colorado, is a multi-agency, multi-discipline group. The goal was to establish an entity which could utilize the contributions of different agencies and persons from different disciplines to advance the state-of-the-art and become the center of activity related to instream flow assessments.

The IFG was established to address—and to interrelate—the major components of instream flow activities: the physical, the biological, the recreational, and the decision-making. Physically, it is necessary to have a basic understanding of the possible changes in stream channel morphology and hydraulics resulting from altered flows. Biologically, it is necessary to be able to predict what effect changes in the channel configuration and other hydraulic factors will have upon the aquatic life and recreational uses. Decision-wise, an awareness is needed of management and operation processes and the legal and institutional constraints of the decision arena.

These components must be pursued equally. They must be related to one another in order to keep the physical, biological, and recreational investigations focused on relevant possibilities, and to keep the assessment of legal and institutional strategies focused on sound principles.

□"develop improved methods for assessing and predicting instream flow requirements for fish, wildlife, other aquatic organisms, recreation, and aesthetics*."

Accomplishments of the IFG in this area include:

■ Methodology for Incremental Analysis of Alterations in Stream Flow and Channel Characteristics.

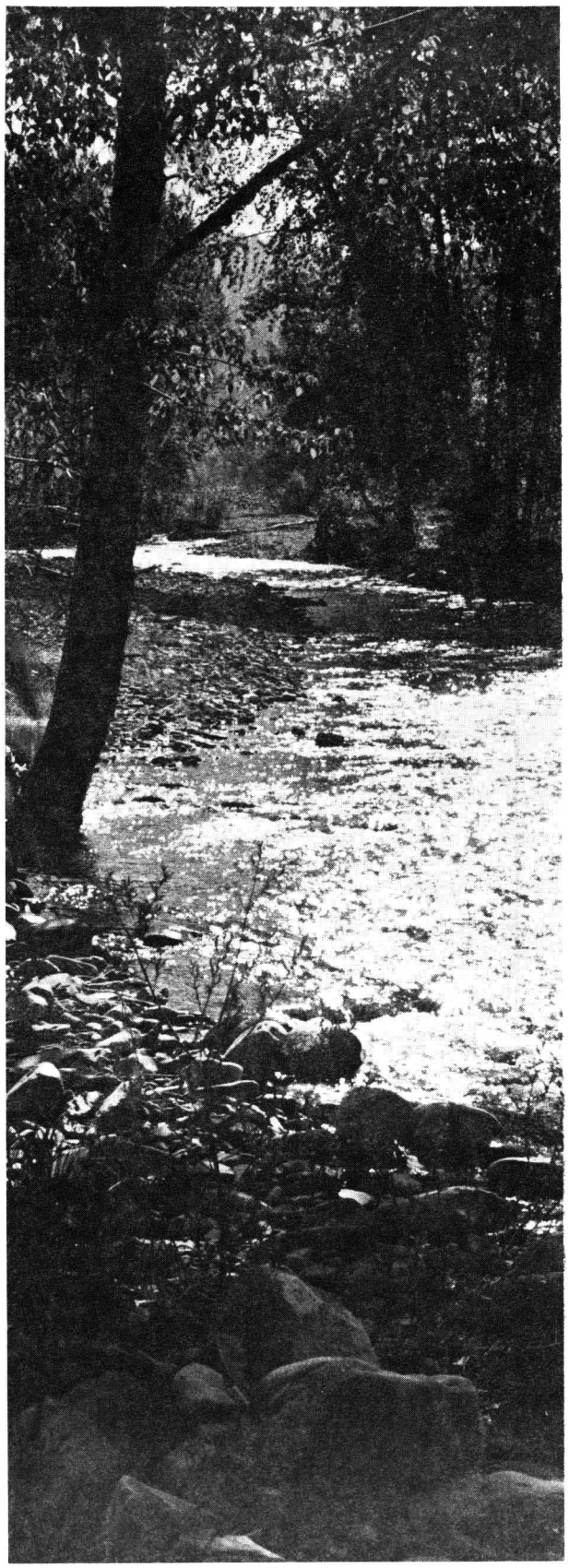
This new and promising methodology enables the investigator to identify limiting times of the year and critical life history stages of selected fish species. It also provides him the option of defining the type of fishery and the standing crop by quantifying the stream flow requirements to obtain the type of fishery so defined.

The methodology utilizes a physical stream description in terms of combinations of depths, velocities, substrates—and, in some cases, cover—as the physical parameters. For each month and stream flow to be investigated, a three-way matrix is constructed and the stream reach is simulated by hydraulic modeling to determine the amount of surface area of the stream reach containing specified combinations of depth, velocity, and substrate.

Weighted criteria for a specific life history stage of any species or recreational activity are input in the form of electivity curves. Curves are constructed for the physical parameters of depth, velocity, substrate, and temperature. Probabilities of use are then composited for specified combinations of depth, velocity, and substrate parameters, and weighting factors assigned. If the weighting factor for depth were .5, the weighting factor for velocity were .5, and the weighting factor for substrate were .5, then for that combination of parameters, the weighting factor would be .125.

For each cell in the three-dimensional matrix, there is a certain surface area that has a particular combination of depth, velocity, and substrate. A weighted usable area is computed by multiplying the surface area of each cell by the probability of use for that particular combination of depth, velocity, and substrate. For example, assume that 1,000 square feet within a sample reach of stream has a combination of depth between 1 and 1.2 feet, velocity of .5 to 1 foot per second, and a gravel substrate. Assume further that this particular combination of depth, velocity, and substrate has a combined probability factor of .25. The weighted usable area for that cell of the matrix would be 250 square feet. In other words, 1,000 square feet of stream with that particular combination of depth, velocity, and substrate is roughly equivalent to 250 square feet of stream having optimum conditions. The surface area and the weighted usable area

**From the initial planning goals established for the Cooperative Instream Flow Group*



for each cell of the matrix are then summed to determine the total surface area for the stream reach, as well as the total usable area at a given discharge and month.

The weighted usable area can be plotted against discharge by species, by life history stage, and by month. From this plot, it is possible to determine potential changes in standing crop and species composition of fish for the stream reach for a given month at different levels of discharge.

■ Methodology and Conceptualized Data System to Determine Instream Flow Needs for Energy Assessment under Section 13 (a) of the Non-Nuclear Act for the U.S. Water Resources Council.

Comparative instream impacts of proposed new energy technologies—such as coal gasification, oil shale conversion, etc., upon fish and wildlife can be assessed with this methodology without resorting to the collection of site specific data. The methodology involves the use of Riverine Analysis Areas (regionalized grouping of stream types), a Representative Reach Concept, Electivity Curves for Target Fish Species (see following section), and Simulation Modeling Techniques.

IFG staff presented a briefing on the methodology to the EDIC (Energy Development Implications Committee) of the U.S. Water Resources Council on April 19, 1977. An Executive Summary has been prepared in printed form, a Riverine Information Management System (RIMS) proposed, and work is continuing on the remaining volumes comprising the project report.

■ Flow Criteria/Electivity Curves for Fish Species

Curves have been developed to calculate the probable response of 30 target species of fish—during their different life stages—to changes in the aquatic stream environment. These curves can be used to assess the impact of stream perturbations and water development projects.

The criteria are based on the assumption

that individuals of a species will tend to select the most favorable conditions, but will also utilize less favorable conditions, with the probability of use decreasing as conditions approach the end points of the range.

The curves identify the range and preference of each life history stage (of each target species) for the hydraulic parameters of depth and velocity, as well as substrate, cover, and temperature. The following life stages are included: spawning, incubation (primarily nest spawning species), fry, juvenile, adult, and passage (migratory species).

The species selected are primarily riverine in nature and reflect management objectives of the State as well as the kind of habitat utilized. As far as the habitat type is concerned, the target species are grouped into riffle and pool species, with each being divided into large and small river subgroupings.

Work is in progress on the probability curves for some 30 additional species. The curves for different families of fish—such as the Salmonids and the Centrarchidae—will be published as a series of Instream Flow Information Papers.

■ Recreation Electivity Curves

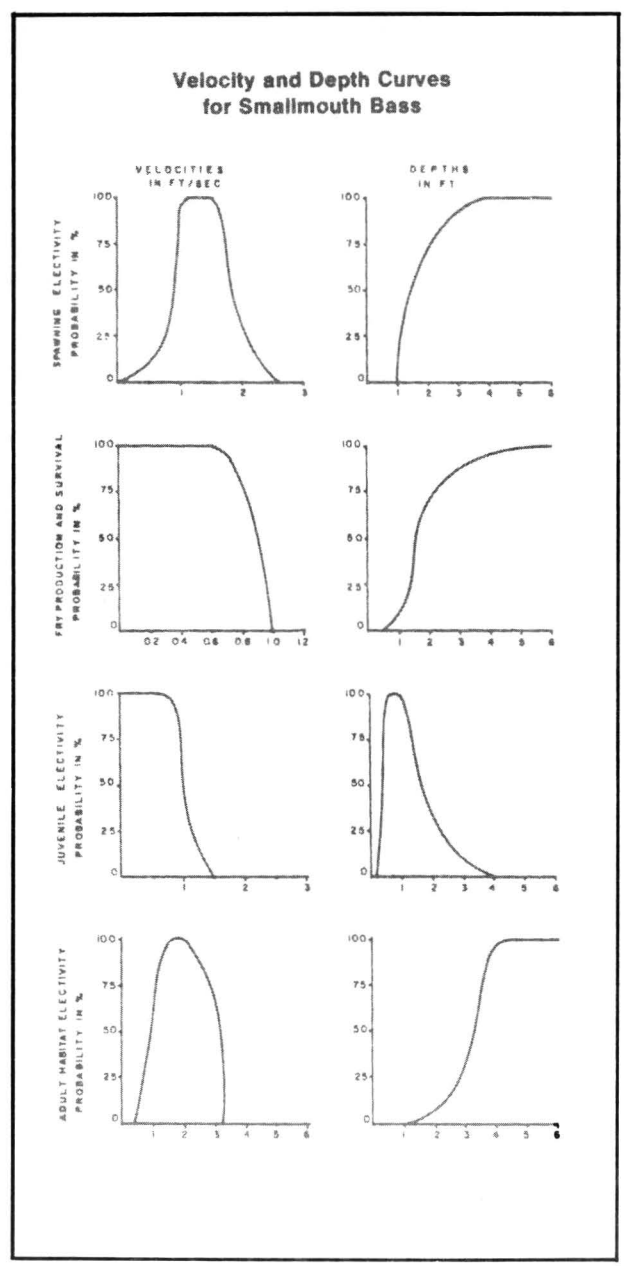
A set of curves comparable to those prepared for fish target species has been prepared for water-related recreational activities. A Bureau of Outdoor Recreation contractor has provided flow criteria in terms of minimum, optimum and maximum depth, width, and velocity. These criteria were set forth for a total of 15 recreational activities. The minimum and maximum flow criteria establish the range of acceptable flows for a recreation activity; and probabilities of recreation use are estimated from these criteria in the same manner as the probabilities are estimated for fish species.

Through use of the recreation electivity curves and physical parameters of the stream, the change in recreation potential which accompanies a change in stream flow can be approximated for any flow-related recreation activity.

This type of analysis will be possible for approximately 20 recreational activities such as swimming, water skiing, etc.

■ Hydrology/Hydraulic Prediction Models

The objectives in developing these analytical tools were to: (1) Determine the depth-velocity-substrate distribution of flow in a stream channel; (2) Determine the monthly pattern of flow and the frequency distribution of the flows, including the frequency distribution of low monthly flows (i.e., average 7-day flows); (3) Determine the impact of modifications in water or sediment discharge on the depth-velocity-substrate distribution of the reach; and (4) Develop



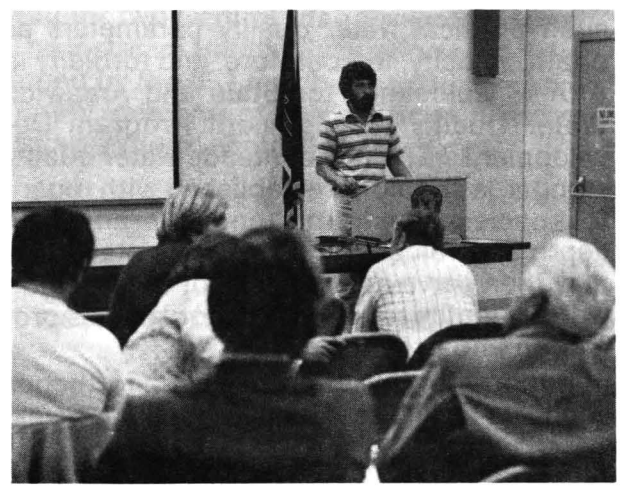
methodologies for collecting the hydraulic data needed for instream flow analyses of large rivers.

The distribution of the depth of flow and the velocity over each substrate type is needed to relate the utility of stream habitat to the flow in a river. This is divided into (a) the determination of a relationship between the level of flow (stage) and the amount of flow (discharge); and (b) the calculation of the distribution of depths and velocities so that a three-dimensional matrix of depths, velocities, and substrates can be developed.

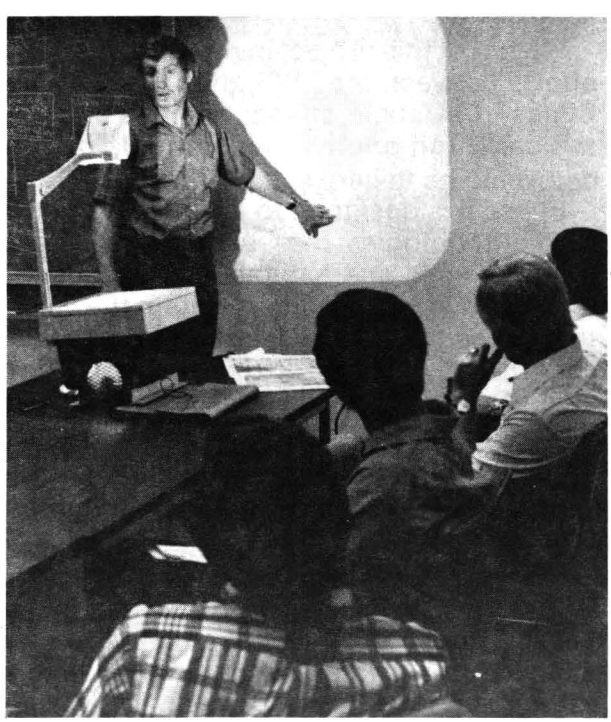
Because the calculations required are long and cumbersome, computer programs are used. This includes a program for use with single cross section data. Also, the use of the USBR water surface profile program, coupled with an IFG program, allows the analysis of multiple cross sections. (The latter is usually preferred.)

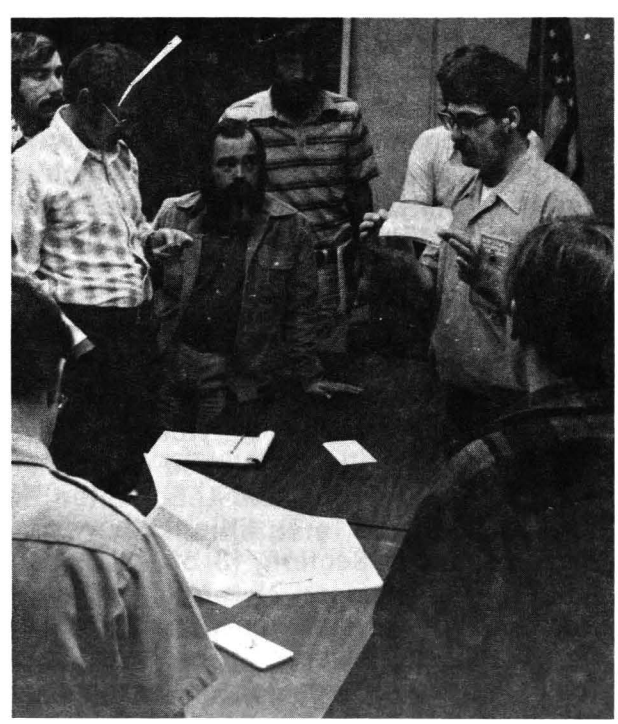
In order to evaluate the quality of the habitat, it is necessary to examine the seasonal and historical range of flows in a stream. Procedures and computer programs to assist in the analysis have been developed for both gaged and ungaged sites, and will be advanced to a state where they can be utilized by non-hydrologists.

Most instream flow analyses have been made assuming the channel will not change as a result of flow modification. In actual fact, the channel may change and the flow needs will not be the same post-modification as pre-modification. Some qualification guidelines for identifying the direction of change have been established.



Information dissemination activities of the multi-disciplinary staff of the Instream Flow Group have included workshops and short courses on Instream methodologies, water law, and computer utilization.





□ "develop and improve guidelines for implementing instream flow recommendations"

■ Water Quality/Quantity Planning

The IFG has indicated to the U.S. Environmental Protection Agency and other organizations that water quality is not a viable concept unless associated with water quantity considerations. IFG has provided input to the EPA that places emphasis on such physical water quality parameters as depth, velocity, temperature, and turbidity in EPA's "Guidelines for State and Areawide Water Quality Management Program Development." The IFG contends water quality standards should be established with regard to species constraints and tolerances to depth and velocity of flow. These standards may then serve as the basis for determining water quantity requirements for species protection and propagation.

Support for this effort has been forthcoming from local, State, and Federal agencies.

■ 1975 National Assessment of Water and Related Land Resources

Assistance was given to the U.S. Fish and Wildlife Service, Division of Ecological Services, in analyzing the fish and wildlife data—including the instream flow approximations—contained in Federal and State-Regional documents. The IFG staff drafted a fish and wildlife chapter, which included an analysis of the future instream flow situation, for the National Priorities Analysis.

■ U.S. Department of the Interior Water for Energy Management Team

A member of the IFG represented the U.S. Fish and Wildlife Service on a five-member team which developed recommendations for assisting the U.S. Water Resources Council in fulfilling its responsibilities under Section 13 of Public Law 93-577 — the Federal Non-Nuclear Energy Research and Development Act of 1974. Section 13 requires assessment of the availability of water for emerging energy technologies.

■ Technical Assistance

A substantial portion (30 to 40%) of IFG staff time has been devoted to work in the following areas:

○ Counseling Strategies

The IFG has responded to a number of requests for advice regarding procedures for protecting instream flows. Consultation in this regard has been undertaken with agency representatives in California, Colorado, Idaho, North Dakota, Montana, South Dakota, Texas, Washington, and Wyoming. These consultations have covered the topics of legal strategies, preparing public hearings, expert witnessing, drafting legislation, experimental study design, and transferring documents.

○ *Evaluation of Methodologies for Establishing Stream Flow Requirements in Thirteen Western States*

The IFG has worked with the Western Water Allocation Research Manager and Regional Activity Leaders of the USFWS to design methodologies for establishing stream flow requirements in numerous western states.

Phase I of this project involved cooperative efforts between the FWS and the respective States to evaluate stream habitats as being critical, high priority, substantial, or limited value as fisheries.

Phase II is designed to evaluate a number of methodologies over a range of stream morphologies and habitats, and to quantify stream flows required to maintain the values that caused a stream reach to be designated as critical or high-priority. These State studies are designed to constitute a rigorous field test in use of the IFG incremental methodology and other methods.

○ *Hydrodynamic and Water Supply Routing Studies*

Assistance was provided to Region 2 of the USFWS in reviewing the program of the Texas Water Development Board to determine the fresh water inflow requirements of estuaries on the Texas Coast.

Assistance and training also were provided

to Region 4 of the FWS relative to the Corps of Engineers' proposed stream diversion, augmentation, and/or storage options to deliver municipal and domestic water to the South Hampton, Virginia area. The IFG's Instream Habitat Evaluation Model has been proposed for use on a regional level to determine those augmentation-depletion options providing the least impact on stream fisheries. Such assessments would be used to aid the Corps in selecting the two or three most feasible water delivery options. A site specific analysis, using a more detailed approach with the Instream Habitat Evaluation Model, would follow to determine impacts and mitigation procedures for each of these options.

○ *River Studies*

The IFG has provided data analysis, as well as designed and reviewed research, on such streams as the Columbia, the Flathead, the San Juan, and South Platte, the Tuolumne, the Upper Colorado, and the Yellowstone.

○ *Stream Channel Design*

Assistance was given to USFWS Division of Ecological Services and the Bureau of Reclamation and representatives of the Ute Indian Tribe regarding mitigation efforts proposed for two Central Utah Project streams.

The Instream Habitat Evaluation Model developed by the IFG may be used to compare different designs of the artificial channel utilizing various controlled flows.

□ *"establish an effective communication network for disseminating instream flow information"*

This was the third major area of activity postulated for the Instream Flow Group at its inception. Some of the Group's work in this field includes:

■ Western Water Law Short Courses

IFG staff have developed and conducted two short courses — Colorado (February 15-16) and Oregon (May 16-18) — on western water law. Additional short courses are scheduled for other areas of the United States.

The curriculum includes discussions on the riparian, reservation, and appropriation doctrines, as well as potential legal and institutional strategies which might be used to protect flows for instream uses. These strategies include direct legislative action, continuation of administrative or agency action, contractual arrangements, planning programs, and judicial doctrines and procedures.

■ Workshops on Computer Analysis of Stream Hydraulics

Workshops on the use of velocity-depth criteria and computer programs for analyzing the benefits of instream flows were held in Utah and in California by IFG staff. The Utah session, held in Salt Lake City on May 25 and 26, was co-sponsored with the FWS Ecological Services Office of that area. Personnel from the U.S. Bureaus of Land Management and Reclamation attended, along with representatives from Utah agencies and the Fish and Wildlife Service Regional Office.

■ Instream Flow Information Papers

○ "Methodologies for the Determination of Stream Resource Flow Requirements: An Assessment" — a documentation and evaluation of instream flow methodology development in the areas of fisheries, wildlife, water quality, recreation, and aesthetics. (199 pages)

○ "Guidelines for Preparing Expert Testimony in Water Management Decisions Related to Instream Flow Issues" — presents information for field biologists and other professionals on the giving of expert testimony in judicial proceedings concerned with instream flows. (42 pages)

■ "Instream Flow Briefs" and Other Related Activities

The IFG has published three issues of "Instream Flow Briefs," established a central depository of reports and information on instream flow assessments, and developed an extensive mailing list.

■ Articles, Papers and Formal Presentations

"The Transfer of Water Resources Management Information — the Cases of the Washington State Department of Ecology and the Cooperative Instream Flow Service Group," presented to the Second International Conference on Transfer of Water Resources Knowledge, held at Colorado State University, Fort Collins, Colorado, June 30-July 2, 1977, Robert T. Milhous.

"Water Allocation and Instream Uses," presented to the National Conference on Water, St. Louis, Missouri, May 23 - 25, 1977, Clair B. Stalnaker (with William H Honore).

"Instream Flow Protection Under the Law," U.S. Forest Service Conference on Water Rights, May 23, 1977, Denver, Colorado, Berton L. Lamb.

"Strategies for Protecting Instream Flow Values," Water Law Short Course II, Warm Springs, Oregon, May 18, 1977, Berton L. Lamb.

"Water Supply vs. Recreation and the Fishery — Minimum Stream Flows," American Waterworks Association, 1977 Annual Meeting, May 9, 1977, Robert T. Milhous.

"Water: The Next National Crisis?," Outdoor Recreation Action, Spring 1977, Keith D. Bayha (with William H Honore).

"Strategies for Preserving Instream Flows," EPA National Conference on 208 Planning and Implementation, April 20, 1977, Denver, Colorado, Berton L. Lamb.

"A Tale of Two Rivers: Agency Behavior in Establishing Instream Flows," American Society for Public Administration, Atlanta, Georgia, March 31, 1977, Berton L. Lamb.

"Water Law and Water Management," Water Resources Research Institute, University of Wyoming, Laramie, Wyoming, February 23, 1977, Berton L. Lamb.

"Abstraction, Appropriation, and Instream Flow Needs," Fisheries, Vol. 2, No. 1, January-February 1977, Clair B. Stalnaker.

"Determination of Instream Flow Needs," presentation to New Tools in Habitat Evaluation and Assessment Seminar, January 6, 1977, co-sponsored by the Office of Biological Services, U.S. Fish and Wildlife Service and the Wildlife Management Institute, held in Washington, D.C., Clair B. Stalnaker.

"Water for Energy Development," a plenary panel presentation to the Conference on Water for Energy Development, Asilomar, California, December 8, 1976, Keith D. Bayha.

"Legal and Institutional Aspects of Instream Flow Protection: Work of the Cooperative Instream Flow Service Group," presented to the Pacific Northwest River Basins Commission, December 2, 1976, Keith Bayha and Berton L. Lamb.

"Water Resource Decision-Making," George Fox College, Newberg, Oregon, October 5, 1976, Berton L. Lamb.

"Legal and Institutional Aspects of the Instream Flow Protection: Work of the Cooperative Instream Flow Service Group," presented to the Pacific Northwest River Basins Commission, December 2, 1976, Keith Bayha and Berton L. Lamb.

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□ *"The Instream Flow Group is conceived (to be) a multi-agency, inter-disciplinary entity..."*

Although formed under the sponsorship of the U.S. Fish and Wildlife Service, the Instream Flow Group is composed of representatives from various Federal departments and bureaus, as well as from State resource agencies and educational institutions serving under the Inter-Governmental Personnel Act.

Clair B. Stalnaker — Group Leader and Aquatic Biologist

Administration of multi-disciplinary and aquatic research, systems and aquatic ecology and management, methodological aspects of instream flow assessments, physical aspects of stream ecology. Fish and Wildlife Service, July 1976.

Keith D. Bayha — Ecologist

Administration of national and regional water resource assessment studies, riparian and aquatic wildlife ecology and management, operational project analysis and environmental impact studies, multi-disciplinary aspects of instream flow requirements. Fish and Wildlife Service, July 1976.

Kenneth Bovee — Aquatic Systems Analyst

Hydrology, sediment transport, stream ecology, riparian vegetation, ice formation, methodology research and development. On IPA assignment from the University of Montana. December 1976 to December 1977.

Timothy Cochnauer — Aquatic Ecologist

Administration of statewide instream flow program, large river methodologies. On IPA assignment from the Idaho Fish and Game Department. January 1976 — July 1977.

David C. Flaherty — Interpretive Writer and Multi-Media Specialist

Film documentation (still and motion) of new developments in water resources, interpretive writing of the significance of new aspects of science and technology, graphics design, publication procedures. On IPA assignment from Washington State University. June 1977 — July 1978

Ronald Hyra — Outdoor Recreational Planner

Recreational water resource assessment, reservoir recreation planning, State outdoor recreation planning, recreation research, assessing instream flow requirements for outdoor recreation and aesthetics. Bureau of Outdoor Recreation. April 1977.

Berton L. Lamb — Specialist in Legal and Institutional Affairs

Political science, natural resource administration, water resource politics, administrative decision-making. On IPA assignment from Eastern Kentucky University. August 1976-August 1978.

Robert T. Milhous — Hydrologist

Water resources planning and administration, hydrology, bedload and general sediment transport, water resources systems analysis, low flow aspects of water resources management. On IPA assignment from Washington State Department of Ecology. October 1976-September 1977.

Helen M. Nelson — Secretary

Fish and Wildlife Service. July 1976

Others who have served with the IFG on temporary appointments include Diane Fisher, James Fogg, Stewart Olive, Walter Stockla, and Sandra Witek.

As the Nation's principal conservation agency, the U.S. Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

☆U. S. Government Printing Office-1977-780-713/77