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BIOLOGICAL SERVICES PROGRAM

CAL YEAR 1976

MASTER

and Wildlife Service

United States Department of the Interior

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Biological Services Program

Fiscal Year 1976

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Prepared by

The Office of Biological Services
U.S. Fish and Wildlife Service
United States Department of the Interior
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Foreword

The Department of the Interior faces broad new challenges in fulfilling its role as the principal steward of the Nation's public resources. There is a growing concern both within the Department and among an informed public on how to identify and accommodate the real physical and environmental limits that exist on the development of these resources. The Department is evolving new policies to better deal with the rapidly increasing demand for the development of resources. The new policies are concerned with maximizing the public benefits from such resource development while placing a new emphasis on renewable but fragile resource values—values such as fish and wildlife resources that are not generally measured in the marketplace. Past development decisions were too often treated in a single context of development versus environmental preservation. However, there is a growing realization that between these two extremes are any number of other choices providing for degrees of development and adequate protection of the environment. The Fish and Wildlife Service is taking a leadership role in providing ecological information as one of the bases for the Department's decision-making responsibilities relative to resource development.

This report presents the second year of activities for the Biological Services Program. The Program is already making its mark on resource decisions through the assembly and application of information and expertise. This report describes the individual projects of the Biological Services Program, its wide-ranging activities, and the more than 120 applied research studies currently underway or recently completed. In addition, the report details the Biological Services Program organization and its efforts to cooperate with and assist other organizations within the Service, Department, and States.

President Carter's far-reaching Environmental Message of May 23, 1977, recommends many measures designed to improve the protection of wildlife and natural ecosystems. The message also strongly recognizes the need to improve our knowledge and analyses of environmental conditions if we are to accomplish our environmental goals. It poses to the entire Service one of the greatest challenges and opportunities of its history. This opportunity did not just happen; in a way it is a recognition of the skill and dedication of Service people. All signs now point to the continuing need within the Service for the type of informational services being provided by the Biological Services Program. Through the work of such programs as Biological Services and application of its findings throughout the Fish and Wildlife Service, the Service will continue to meet the challenges posed by this new age of resource scarcity and will continue to find a prominent place in our Nation's resource and environmental programs.

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

Introduction

Need for Ecological Information

Our Nation's growth is consuming land and water resources at an increasing rate and one unfortunate result is that fragile fish and wildlife habitats, which are an intrinsic part of America's resource base, are being disturbed and destroyed. There is no escaping society's dependence on natural resources to provide energy, raw materials, food, and living space for our material well-being, but we cannot afford in the process the wholesale sacrifice of aesthetic, recreational, and ecological values of our unique wildlife heritage.

Somehow the conflict between development and preservation of natural resources must be reconciled. We need a far better understanding of the wildlife ecosystems that are being disturbed by development so we can identify more precisely what resources we can most afford to lose, if necessary, and those which we must make the most determined effort to save. Such an understanding is essential for the future well-being of the Nation.

On the horizon are energy development programs that will seem very attractive as we carry out our national policy of increasing energy self-sufficiency. Many, however, pose potentially drastic environmental effects. It is anticipated that in the decade ahead many thousands of acres of land in the Great Plains and the arid Southwest, much of it government-owned will be opened to the strip mining of coal. Thousands of offshore wells will be drilled in the Outer Continental Shelf to locate and exploit new deposits of oil. Mountains of spent rock may be created in Colorado and Utah if and when extraction of oil from shale becomes economically attractive. Extensive development of geothermal

energy sources will undoubtedly affect prime areas of wildlife habitat. Furthermore, development of energy resources will be accompanied by construction of new electric generating plants, transmission lines, refineries, synthetic fuel plants, and transportation facilities. Worker boom towns will also be established. All of these new activities will have a major impact on the land and will create, to the detriment of fish and wildlife, even more competition for already scarce water supplies.

MAGNITUDE OF THE PROBLEM

Energy represents only one aspect of the resource development problem. Each year, more and more wildlife habitats are lost to wetland drainage; the widening, straightening, and deepening of streams; dredging and filling of coastal

percent, of the higher animals in the country are in danger of extinction.

Moreover, a review by the Service's Office of Endangered Species shows that 100 species (about 10 percent) of clams and 200 species (10 percent) of snails also appear to be threatened with extinction. Other studies have found that the same threat faces approximately 10 percent of all North American plant species, many of them important to the survival of animal species and wildlife communities.

The implications of these losses to man, who is dependent upon thousands of species of living organisms for his existence, have not been fully assessed. But, at the very least, it is certain that these losses collectively represent an ominous deterioration of the environment.

Concern for maintenance of environmental quality has sprung from a deep-seated public awareness that man is dependent on certain

waters; highway construction; non-fuel mining; urbanization; pollution; and the like. Currently, an estimated 700 major land and water resource development projects are in progress or planned by State and Federal agencies and private industry.

The activities of man have caused the extinction of about 60 species of higher vertebrates (mammals, birds, fishes, reptiles, and amphibians) in the United States in the last 200 years. Recent Fish and Wildlife Service studies have revealed that approximately 200 species, or 10

environmental factors for his physical, emotional, and social well-being. The ultimate linkage to environmental quality is well understood to everyone—some level of clean air and water is essential to survival. However, the threshold limits in environmental quality, below which human well-being begins to deteriorate, are not well identified.

Is it important that planners find out the impacts of an action on fish and wildlife resources? Given the present inability of environmental evaluators to match the speed,

accuracy, and scope of economic and engineering analysis, is it worth the occasional delays involved to include the environmental scientist with his small but growing supply of analytical tools on the planning team?

Without claiming to exhaust the subject, there are several points to be made in responding "yes." First and foremost, we wish to preserve fish and wildlife for their resource value per se. In addition, fish and wildlife may be general

Indicators of the biological health of environments. Man, in ways sometimes obvious and sometimes subtle, depends on many of the same environmental factors as does wildlife. In brief, what is good (or bad) for wildlife tends to be good (or bad) for man. Life processes are essentially similar in their dependence on certain elemental factors. Man differs from other forms

in that he can expand the area from which his food and shelter materials are drawn. That is, he can offset the loss of one area of habitat by drawing on or importing from the reserves of other areas, and exporting products, including wastes. He has also a greater capacity to substitute and adapt different resources. This flexibility, however, has limits in time and space.

Ecologists have a responsibility to determine the relationships between man and the critical elements of the environment—both the immediate environment in which he lives and the global environment on which he also depends. Until we understand these sensitive linkages more precisely, it is preferable to preserve future options and err on the side of caution, safety, and minimal disturbance.

MEETING THE CHALLENGE

Under the National Environmental Policy Act, the Fish and Wildlife Coordination Act, and other Federal legislation, the Fish and Wildlife Service has been involved in many environmental issues, both through research and on an operational basis. The Biological Services Program is one of three interrelated programs in the Fish and Wildlife Service dealing with environmental issues. The other two are the Land and Water Resource Development Program and Environmental Contaminant Evaluation Program.

The Land and Water Resource Development Program, managed through the Division of Ecological Services, provides consultation, field evaluation, and planning assistance for proposed water and related land projects to be constructed by Federal agencies, assisted with Federal funds, or constructed by non-Federal entities under a Federal license or permit. The Program provides ecological input to field level planning related to specific river basin studies and assures Fish and Wildlife Service compliance with the National Environmental Policy Act.

The Environmental Contaminant Evaluation Program involves research studies, contaminant monitoring, and field appraisals to ascertain the effects of pesticides, industrial chemicals, heavy metals, and pollutants on fish and wildlife and their habitats. The preparation and review of all Service uses of pesticides is accomplished by this program. Much has been accomplished toward uncovering the relationship between the application of pesticides and damage to fish and wildlife.

The increasing number and complexity of major land and water development projects has required that the Service upgrade its response capability by improving the basic data, methodologies, and predictive tools available to address these issues. It has been obvious that much of the damage to fish and wildlife resources, stemming from new land and water developments, could have been avoided or mitigated if projects had been planned with greater consideration for environmental values and if conservation recommendations had been better justified, documented, and accepted. Specifically, it is important to demonstrate the values of particular habitats to decision makers, and to prove that alternative plans could preserve such values and be justified in terms of cost. At the same time, it has become apparent that the Service must have a capability of assessing project impacts more rapidly and accurately if it is to stay abreast of the deluge of new projects related to energy, impairment of wetlands, and proposed changes in land and water use. In short, the operational part of the Service needs to be strengthened and provided with the means of making them more effective and more efficient.

To remedy this situation and reinforce the Fish and Wildlife Service's role as a central source of ecological expertise and information in the Department of the Interior, the Service has created the Biological Services Program. The Program has been given a high priority to accomplish the following threefold mission:

1. To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.
2. To gather, analyze, and present information that will aid decision makers in the identification and resolution of problems associated with major land and water use changes.
3. To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

AN INFORMATION BRIDGE

In performing its mission, the Biological Services Program acts as a bridge between Fish and Wildlife Service activities at the research

level and those at the field operations and management levels. In addition to supporting research and studies on critical environmental problems, Biological Services is synthesizing scientific research data into operationally useful guidelines and manuals and providing technical assistance on environmental problems directly to Fish and Wildlife Service Regional Offices, as well as to other agencies. Over a period of time, this work is expected to greatly enhance the Service's ability to provide pertinent information on wildlife resources and their supporting ecosystems throughout the country.

The Program helps the Fish and Wildlife Service to participate in the decision-making process for major resource development projects in a manner that helps narrow the traditional conflict between economic development and environmental protection. For example, under an order issued by the Secretary of the Interior on April 30, 1975, the Fish and Wildlife Service is providing expert advice to the Bureau of Land

Management and the Geological Survey on ecological problems associated with development of new oil and gas resources on the Outer Continental Shelf. The Service is also developing information that will assist in finding the least damaging ways of bringing the oil and gas ashore and in determining the best locations for shore-based facilities. Within the various oil and gas lease areas, the Fish and Wildlife Service is identifying critical zones that should not be developed and is analyzing alternatives to preserve these critical areas while projects are in

the early planning stage, when options are still available. Strengthened coordinated activity among the Department's agencies is expected to be extended to other areas of energy, land, and water development.

In the future, working in close cooperation with other Fish and Wildlife Service Divisions,

After completing its second year of operation, the need for the kinds of services and information that the Biological Services Program can provide has become more apparent. Interest in the program, by both Federal and private agencies, has increased as research projects are completed and products become available.

Biological Services' personnel will be advising on such matters as how to determine the amount of water that must be left in streams to sustain fish and wildlife resources and how to locate high-voltage transmission corridors in relation to important wildlife habitats. They will also be recommending stipulations in mining and other types of Federal leases that will protect important wildlife species, as well as advising how disturbed land should be rehabilitated. In the process, research will be directed at opportunities for enhancing fish and wildlife resources.

Findings of the Program are already beginning to be implemented into practice by planners and decision makers.

Finally, it should be emphasized that the Biological Services Program is dedicated to searching out the facts as objectively as possible and making them known to the public. The general public needs this information to deal with the many difficult environmental decisions that lie ahead. The availability of accurate information will help make the choices clearer, if not easier.

Program Scope and Organization

The major natural resource development projects started every year in the United States involve many people in the planning stages. These individuals serve at legislative, technical, and administrative decision-making levels in Federal, State, and local governments, as well as in the private sector. If fish, wildlife, and related ecological resources are to receive consideration as resource development project plans evolve, these people—as well as the general public—must be kept fully informed concerning environmental impacts. The information they receive must be authoritative, accurate, and above all, timely.

Biological Services has designed a comprehensive program for meeting these requirements. The staff is constantly gathering, synthesizing, and packaging scientific information that can be employed early in project planning cycles to facilitate effective decision-making on ecological matters. Biological Services is not engaged in writing environmental impact statements (EIS's), but rather is providing input which will strengthen specific EIS's with better information. Information is presented in the form of manuals, guidelines, and documents, which describe the floral and faunal composition of ecosystems and the probable effects of development, and set out alternatives for avoiding, mitigating, or repairing environmental damage. The overall objective is to guide decision makers involved in the development and protection of natural resources toward eliminating environmentally unacceptable options and toward choosing methods having the least potential for environmental harm.

PROJECT CATEGORIES

The Program is structured around specific projects which the Fish and Wildlife Service has designated as critically important to the environment. These projects deal with problems associated with energy development, other types of land and water developments, and activities of a supporting nature.

The projects related to energy development have been formulated and funded as part of the Federal Government's accelerated energy research and development program. They reflect a recognition of the need to take environmental values into consideration in the development of new energy sources. The traditional kinds of land and water development issues include water resources development and coastal alterations. Support projects are concerned with the transfer of information and the classification, inventory and analysis of habitats. Specific projects of the Biological Services Program include:

Coal

Power Plants

Systems and Inventory

- Habitat Classification and Analysis
- National Wetland Inventory
- Information Transfer

Coastal Ecosystems and Outer Continental Shelf Development

Water Resource Analysis

- Stream Alterations
- Western Water Allocation

Geothermal, Oil Shale, and Minerals

PROGRAM SUMMARY

The Biological Services Program was initiated in the fall of 1974. The first year's effort (FY 1975) was devoted principally to developing, organizing, and staffing the Program; establishing priorities; initiating studies directed toward a number of important informational needs; establishing cooperative working relationships with a number of other agencies; and advising on fish and wildlife stipulations being incorporated into leases granted for geothermal and Outer Continental Shelf (OCS) oil and gas development.

During FY 1976 the organizational structure has been refined, basic staffing completed, and the first products resulting from Biological Services Program work are becoming available and being distributed. Much progress has been made in increasing productivity as project areas

have become more clearly defined, as the Biological Services role within the Fish and Wildlife Service has become better understood, and as new initiatives begin to bear fruit. The scope of the Program has expanded and the now solidly established working relationships with a number of other government agencies serve to increase Program effectiveness.

The type of ecological problems being dealt with in the individual project areas is discussed in Chapter 3. The more than 120 studies initiated or completed in FY 1976 and the FY 1976-77 transition quarter are described in Chapter 4. Included in Chapter 4, for the sake of completeness, are some of the studies actually begun in the first quarter of FY 1977.

Briefly, some of the principal project activities are as follows:

Coal Project

Attention is focused on protecting and restoring fish and wildlife habitats in surface mining areas of the Great Plains, the Southwest, and Appalachia. Research is underway on methodologies for surveying and characterizing ecosystems by key variables, including the presence of rare and endangered species, so that important habitat areas can be quickly identified and protected under Federal leases.

Wildlife oriented reclamation strategies and methods are being developed for application to abandoned and active strip-mined areas. Remote-sensing imagery is being used to develop rapid assessment methods to identify sensitive habitat, vegetation, and land-form types in affected areas. Bibliographies of useful information are being compiled to facilitate access to needed data by planners and decision makers.

Power Plant Project

Approximately 350 major new steam electric power plants are expected to be built in the United States during the next decade. This project's research efforts are concentrated on preventing or minimizing losses of aquatic life in streams, lakes, and estuaries used for cooling such plants and for reducing the potential loss of wildlife habitat by construction. The project also is studying ways of locating transmission corridors to minimize habitat disturbance and studying ways to better manage transmission line rights-of-way for wildlife.

Systems and Inventory Activities

This group of projects functions in support of Biological Services, Habitat Preservation, and other Service activities, and also provides valuable services to other agencies. It consists of projects designed to: (1) develop standard, widely applicable fish and wildlife habitat classification, analysis (including the systematic use of biological indicators), and inventory methods needed by many agencies involved in natural resource planning, management, and impact assessment; (2) conduct a nationwide inventory of wetlands, a habitat type requiring priority attention; and (3) develop, implement and manage an Information and Technology Transfer System that will effectively and efficiently provide the Service and other agency decision makers with the information they need to meet their fish and wildlife related resource management responsibilities.

Three projects comprise the Systems and Inventory Activities: Habitat Classification and Analysis, National Wetland Inventory, and Information Transfer.

Habitat Classification and Analysis Project

Comprehensive classification systems for fish and wildlife habitats of the United States are being developed in cooperation with several other resource management agencies. These will

be used as the framework for geographical/ecological data management and information systems. Ecological data will be stored, analyzed, and displayed as required for various assessment and planning activities.

National Wetland Inventory Project

The operational inventory was begun in FY 1977 and will be finished in FY 1979. It will update the last national inventory conducted by the Fish and Wildlife Service in 1954. A new hierarchical wetland classification system will be used for the inventory. Surveys of existing aerial photography and recent State and local wetland surveys have been completed.

Information Transfer Project

Information transfer mechanisms are being developed to identify specific information needs and to expedite the flow of information from the Biological Services Program and other sources to decision makers and the public. Staff are able to draw upon the information in existing data bases via computer terminal links. As part of its information exchange mission, Biological Services has also participated in the sponsorship of a number of scientific meetings and workshops to facilitate effective communications between researchers, policymakers, and others interested in the environment.

Coastal Ecosystems and Outer Continental Shelf Development Project

These activities reflect the growing importance of accelerated offshore oil and gas development and its effect on the Nation's coastal systems, as well as effects of more traditional forms of coastal alteration. The project is developing approaches to characterize the coastal areas to better understand, predict, and compensate for multiple impacts of development on fish and wildlife resources. Particular emphasis is being placed on potential impacts on coastal birds, endangered species, and high value habitats. In addition, this project supports Service participation in the Department's Outer Continental Shelf (OCS) Development Program. A manual is being developed for evaluating the full range of offshore oil and gas development impacts upon coastal ecosystems.

Water Resource Analysis Activities

These projects consist of applied research, analysis, and technology transfer on two critical water resource development problems: stream alteration and western water allocation. The objectives are to develop improved capability to assess the ecological impacts of these activities, to mitigate or prevent ecological damage, and to assure that information is rapidly available for use within and outside of the Fish and Wildlife Service. The findings are utilized in the operations of the Land and Water Resource Development Planning Program under the Fish and Wildlife Coordination Act and by other agencies in their water development activities.

Stream Alterations Project

Various studies are being conducted in all areas of the country, including Hawaii, to assess

in the West. This project is identifying where water allocation decisions are being made on State and Federal levels and is developing scientific information related to streamflow requirements for maintaining fish and wildlife resources, including endangered aquatic species. These new approaches are being tested and applied throughout the western States and include extensive State cooperation.

Geothermal, Oil Shale, and Minerals Project

This activity deals with the ecological effects of the Department of the Interior's terrestrial energy and minerals development programs, other than coal. Activities consist of applied research, technology transfer, and operations support. The objectives of these efforts are to develop an improved capability to deal with impacts of

the effects of stream channelization on different types of fish and wildlife habitats (including riparian vegetation) and to develop mitigation methodologies and procedures. Research also is underway on the ecological effects of large-scale removal of gravel from streams in Alaska. The gravel is needed in great amounts for virtually all kinds of construction in the north to insulate the frozen ground beneath pipelines, airports, roads and buildings.

Western Water Allocation Project

Future coal and oil shale development will greatly tax the already limited supplies of water

various terrestrial developments through strengthening Service field capability, to obtain information on important ecosystems, and to develop habitat protection techniques for Federal lease management.

FUNDING AND RESOURCES

The FY 1976 budget for the base program was \$8,490,000 plus \$4,512,000 in funds transferred from other agencies. The following section deals with budgetary resources and interagency cooperative agreements for the Biological Services Program.

**OFFICE OF BIOLOGICAL SERVICES
PROGRAM FUNDING**
(dollars in thousands)

Project	FY 1975	FY 1976	FY 1977
Coal	\$600	\$2,170	\$2,620
Power Plants	700	1,001	1,001
Systems and Inventory	1,239	2,439	2,039
Coastal Ecosystems and Outer Continental Shelf Development	500	1,500	1,500
Water Resource Analysis	1,212	1,212	1,212
Geothermal, Oil Shale, and Minerals Development	500	1,000	1,000
Total*	\$4,751	\$8,490	\$9,709

*Totals include Pay Act increases.

**RESOURCES NOT IN FISH AND WILDLIFE
SERVICE BUDGET**
(dollars in thousands)

	FY 1975	FY 1976*	FY 1977**
Geothermal Transfer from Geological Survey	200	—	—
Coal Transfer from Bureau of Land Management	600	—	165
OCS Transfer from Bureau of Land Management	67	—	—
OCS Transfer from Bureau of Land Management (Alaska Study—coordinated with National Oceanic and Atmospheric Administration)	—	1,211	797
Environmental Protection Agency (Interagency Energy Research and Development Program)			
A. Marine Studies	1,100	1,068	1,040
B. Freshwater Studies	785	858	603
C. Terrestrial Studies	710	1,026	700
Water Resources Council	48	200	—
Coal Transfer—Old West Regional Commission	—	60	—
Coastal Ecosystems—EPA	—	38	—
Western Water Allocation—EPA	—	25	—
Coastal Ecosystems—Army Corps of Engineers	—	26	—
Power Plants—Federal Power Commission	—	—	30
Power Plants—Energy Research and Development Administration	—	—	50
Total	\$3,510	\$4,512	\$3,385

* Transition Quarter funds included.

**Additional reimbursable agreements may be negotiated during FY 1977.

INTERAGENCY RELATIONSHIPS

The Biological Services Program is working to develop vigorous and cooperative relationships with a wide variety of other Federal agencies on matters of mutual interest. The relationships often involve the exchange of both money and personnel. Examples include consultation with other agencies in formulating the National Wetland Inventory; cooperating with the Forest Service by providing wildlife information for their work under the Forest and Rangeland Renewable Resources Planning Act; and assisting the Environmental Protection Agency in the devel-

opment of ecological information relating to their regulatory responsibilities for power plants.

The actual exchange of money or personnel include:

- Funds transferred between agencies to conduct projects of mutual interest. In some instances funds are transferred to other agencies that have special expertise to conduct studies needed by the Fish and Wildlife Service. For example, as part of the oil shale issue, moneys were given to the Plant Materials Center of the Soil Conservation Service to conduct research

aimed at the identification of plants most suited to reclamation of strip-mined lands for the benefit of wildlife. Funds were also transferred to the Corps of Engineers to help them develop a sensitive species information system. In a number of instances projects are funded jointly with other agencies, such as a project with the Forest Service to develop a data base on certain animal species.

- Funds transferred to the Fish and Wildlife Service from other agencies because of Service expertise in issues involving biological resources. The Bureau of Land Management provided transfer funds through the National Oceanic and Atmospheric Administration to help support the studies of Alaskan sea bird populations in potential OCS development areas. The Water Resources Council provided funds for aquatic studies related to fish and wildlife water needs in energy development areas. Other sources of transfer funds in FY 1976 included the Old West Regional Commission, Corps of Engineers, Federal Power Commission, and Energy Research and Development Administration.
- Biological Services Program personnel stationed at facilities of other agencies to ensure the effective exchange and utilization of information from Service studies and to provide the agencies with guidance and assistance in conducting their own study programs. Interaction with other agencies to share expertise and information also builds a better understanding of agency missions, goals, and problems. Examples are: a member of the National Coastal Ecosystems Team is stationed at the Corps of Engineers' Waterways Experiment Station in Vicksburg, Mississippi, to provide advice on the Corps' Dredge Spoil Research Program and to keep Service personnel informed of the findings. A wildlife biologist stationed with the National Oceanic and Atmospheric Administration at Boulder, Colorado, provides expertise on Alaskan birds and mammals as part of their overall marine environmental studies program.
- Agencies' staff detailed or stationed with the Fish and Wildlife Service to provide ex-

pertise in specific areas. A Geological Survey hydrologist is detailed to the National Stream Alterations Team; a Forest Service wildlife biologist is serving with the Eastern Energy and Land Use Group; a Soil Conservation Service scientist is stationed with the National Wetland Inventory Group; and a representative of the Bureau of Outdoor Recreation is serving with the Instream Flow Service Group.

ENVIRONMENTAL PROTECTION AGENCY INTERAGENCY ENERGY RESEARCH AND DEVELOPMENT FUNDS

As the Nation's efforts toward meeting national energy needs are carried forward, considerable additional environmental information will be required to permit energy developments to take place with the least possible impacts on environmental quality. To assure a coordinated inter-agency program for the necessary environmental research and development effort, the Environmental Protection Agency (EPA) has established cooperative agreements with other Federal agencies to conduct research on determining the environmental effects of energy development.

During FY 1976, EPA funded several Biological Services projects for a total of nearly 3 million dollars. The projects dealt with a wide range of important ecological problems associated with energy resource development. Those studies specifically supported by these funds are identified in Chapter 4.

STATE FISH AND WILDLIFE AGENCIES

Cooperation with State fish and wildlife agencies is an important aspect of the Biological Services Program because of their basic responsibility for management of resident wildlife species, their expertise and ability to provide valuable data and information on wildlife populations, and their role as a major user of the information being developed. The States have an important role in the program and it is expected to be an increasingly important one. A few examples of such cooperative efforts include: a joint effort with some western States to identify priority wildlife areas as part of the coal leasing

program; State funded studies such as the Yellowstone River study in Montana or the study of six estuaries conducted by the State of California; and technical assistance provided to some of the States, such as work on low flow requirements in some of the western States.

MANAGEMENT AND STAFFING

In FY 1976, a total of 158 positions were assigned to staff the Biological Services Program. The number of permanent Federal employees has been augmented by assignments of personnel under the Intergovernmental Personnel Act, and by seasonal or part-time personnel. Much of the work of the Biological Services Program is done under contract to outside groups.

The Biological Services Program is planned and managed by the Office of Biological Services, which reports to the Associate Director for Environment and Research of the Fish and Wildlife Service (see Appendix A for information on organization and staffing of the Biological Services Program).

Reporting directly to the Office of Biological Services, headquartered in Washington, D.C., are several national teams and groups:

- The National Western Energy and Land Use Team (Fort Collins, Colorado) including—
 - The Cooperative Instream Flow Service Group
 - The Habitat Assessment Group
- The National Stream Alterations Team (Columbia, Missouri)
- The National Coastal Ecosystems Team (Bay St. Louis, Mississippi)
- The National Power Plant Team (Ann Arbor, Michigan)
- The National Wetland Inventory Group (St. Petersburg, Florida)
- The Eastern Energy and Land Use Group (Harpers Ferry, West Virginia—established in FY 1977).

Members of the national teams and groups provide expertise in their various subject areas and possess a broad understanding of ecological problems. They are responsible for outlining studies to be funded by the Biological Services Program based on identified needs for the information, managing research contracts, monitoring in-house studies conducted by Fish and

Wildlife Service research centers, disseminating findings through an active information transfer activity, and providing technical assistance and consultation both in and outside of the Service.

Regional Participation

The Fish and Wildlife Service's Regional Offices have been staffed with Biological Services personnel who focus on problems at the operating level. For example, Regional Offices whose coverage encompasses coastal areas have been staffed with personnel experienced in marine ecology which has strengthened their ability to do work related to coastal development. The western Regional Offices have been provided with personnel who concentrate on such issues as coal, oil shale, and geothermal development.

These specialists are responsible for Regional participation in the Biological Services Program, ensuring that the information needs of the Regions are identified and that available information finds its way into operating programs. In addition, these personnel will supplement and extend the capabilities of the extensive environmental staff already working in the Regional Offices and their associated field stations as part of the Fish and Wildlife Service's Land and Water Resources Development Planning and Environmental Contaminant Evaluation Programs.

Research

Some resources have been assigned to Fish and Wildlife Service research facilities to strengthen performance of in-house research on certain critical issues. For example, the staff and funding of the Patuxent Wildlife Research Center has been increased to work on the chronic effects of low-level oil contamination on water birds in connection with OCS oil development. The Denver Wildlife Research Center is conducting studies on the impact of coal development on wildlife. Other research units are similarly involved.

Staffing

The staff for the Biological Services Program was selected both from within and outside the Fish and Wildlife Service following an intensive recruitment campaign. Outside hires have included people from various State and Federal

Government agencies, as well as from universities and environmental consulting firms.

The Program's personnel represent a number of disciplines. In addition to fish and wildlife biologists and ecologists, the staff includes engineers, economists, remote-sensing experts, information scientists, biometricians, and geolo-

Workshops and courses held or scheduled include:

- A series of courses conducted in Denver, Washington, and Portland dealing with specific phases of Federal contract procurement for research projects.

gists. The Program's emphasis has been to assemble a staff with diverse expertise necessary to attack and resolve complex environmental problems.

The Biological Services Program has actively used its authority under the Intergovernmental Personnel Act (IPA) to bring additional background, experience, and diversity to the staff. The Act enables a mutually beneficial sharing of expertise between State and local governments and the Federal establishment. So far, 13 IPA agreements have been established with disciplines such as economics, urban planning, ecology, wildlife biology, and political science. These individuals have brought valuable backgrounds and new perspectives to the Program's activities while benefiting their own organization when they return through a better understanding of the workings of the Federal Government. Plans are to continue the IPA program.

TRAINING

As part of its overall effort, the Program is conducting an active training program for Fish and Wildlife Service, State, and local personnel.

- A workshop on Creation of Coastal Ecosystems held at the University of Georgia was attended by 25 Service personnel.
- A 2-day workshop held in New Orleans at which oil and gas industry representatives discussed various aspects of off-shore

- operations with Service personnel.
- Training courses on interpretation of medium to small-scale color infrared photography and satellite imagery for vegetative cover mapping presented by the Application Assistance Branch of the Geological Survey's EROS Data Center.
 - Geothermal workshops conducted in Denver, Colorado; Clear Lake, California; and El Centro, California, during FY 1976 to serve as an overall orientation to the geothermal program for various staff from Federal, State, and private sectors and to concentrate on identifying and streamlining the needed coordination and informational exchange between State and Federal biologists to meet the Federal leasing program.
 - A Basic Power Plant workshop held in Ann Arbor, Michigan, for Fish and Wildlife Service Regional staff to review power plant technology and impacts in relation to fish and wildlife resources.
 - An Oil Spill workshop cosponsored by the Coastal Ecosystems and Outer Continental Shelf Project and the Service's Migratory Bird Management Program, reviewed the Service's oil spill contingency plans and briefed the Regional Oil Spill Response Coordinators on latest techniques for managing the effects of spills on fish and wildlife.
 - An Environmental Assessment workshop conducted by Virginia Polytechnic Institute and State University to review with Fish and Wildlife Service personnel the state-of-the-art in methods, processes, and activities used in evaluating and predicting the environmental consequences of various types of resource development.
 - A Hydrology Short Course held at the Geological Survey's Denver Training Center for Ecological Services personnel to serve as a general introduction to engineering principles and methodologies of channel, bridge, and water control design was presented.
 - A Water Law Short Course at Colorado State University attended by 117 persons from Federal, State, and private agencies to discuss strategies involving riparian, reservation, and appropriation doctrines.

Program Overview

The Biological Services Program strives to improve the quality and efficiency with which the numerous important decisions affecting the Nation's fish and wildlife and their habitats are made. To do this requires a constant sensitivity to emerging complex ecological problems so that needed data and methodologies can be developed before major decisions are made. The lack of such a systematic approach in the past has contributed to environmental values not being fairly weighed in development decisions, resulting in costly litigious delays. The complex problems with which the Program must deal require accurately organizing, analyzing, and evaluating both existing and new data. The Biological Services Program also attempts to identify who requires assistance with environmental decisions and where and when the information must be transferred to achieve the best result. The specific activities developed in response to this challenge are described in this chapter.

The Program has developed a fivefold strategy for dealing with the major environmental problems it has under study. The first element of this strategy is to describe and analyze selected regions and ecosystems under stress from resource development. The Program seeks to work on regions that are of important environmental concern from the standpoint of their ecological values. In these areas, various approaches are being used to provide baseline information to characterize the ecosystems concerned, including assembling and interpreting all available existing information.

For some areas such information is extensive, but has not been compiled and summarized in a meaningful form. Where there is a lack of relevant data, extensive field studies are required.

The second element is to specify impacts on fish and wildlife resulting from various forms of development. An important prerequisite for preventing or minimizing environmental damage is the capacity to predict the damage. It is necessary not only to describe primary impacts, such as the immediate impact of strip mining, but also to identify and describe secondary impacts, such as those stemming from related industrial development and population growth.

Both elements of the Program strategy involve improved approaches, tools, and methodologies for evaluating habitats and assessing environmental impact. Emphasis is being placed on more highly quantitative approaches, remote sensing, and other advanced analytical techniques to identify habitat values and impacts of resource developments.

The third element involves establishing a capability for examining alternatives, mitigation methods, and management strategies aimed at minimizing environmental damage. Better ways to contribute to the resource planning and development process are being sought to ensure that ecological concerns are made known to resource planners and managers as early as possible.

The fourth element of the Program involves developing information transfer techniques and procedures so that ecological findings can be more effectively used in decision making. This requires the conversion of research results into readily usable formats, development of manuals and handbooks, presentation of workshops and training courses, and development of effective information storage and retrieval mechanisms.

Finally, the Biological Services Program seeks to strengthen effective Fish and Wildlife Service participation in the planning and decision-making process through use of Regional personnel and national teams. This requires close coordination between operational elements of the Service, particularly the Regional and Area Offices, and other agencies involved in resource development.

The results of the various Program studies are expected to reveal fish and wildlife habitats that may be under particularly heavy pressure from various aspects of development. The studies will show which resources are required—in terms of habitat, land, vegetation, and other supporting factors—for fish and wildlife maintenance and proliferation. They will also identify interrelationships among organisms, ecosystems, and development alternatives.

Numerous methodological improvements are expected to emerge as a result of the Program's efforts. Studies designed to characterize geographic areas and ecosystems under potential development pressure will be useful in ecological analyses and in modeling ecosystems. They also will enable analysts to develop parameters for classifying and comparing ecosystems, which, in turn, will assist administrators in making decisions about where and what types of development should be permitted.

Improved procedures are being developed for sensing and measuring environmental features. These techniques will provide better means for establishing environmentally preferred options, and also will serve as bases for specifying measures to protect key ecological features. Monitoring techniques are being developed to assess the effectiveness of decisions to protect the environment after they are implemented, as well as indicate where adjustments are necessary.

The Biological Services Program has contracted with research facilities of the Fish and Wildlife Service, universities, environmental consulting firms, and has entered into cooperative projects with other Federal agencies to deal with topics in each of the Program's project areas discussed below.

COAL PROJECT

The Coal Project provides expertise and ecological information on fish and wildlife resources and their habitat for policy and program decisions by the Department of the Interior agencies concerned with coal development. Activities and studies are designed to assure timely, efficient, and effective utilization of ecological information in coal development decisions. The same information will be available to State agencies and private groups, including mining companies.

Coal constitutes 90 percent of our domestic hydrocarbon fuel reserves, and must play an increasingly important role as supplies of natural gas and oil decrease. More than half of the Nation's coal reserves are in the western part of the country. Western coal occurs close to the surface in seams up to 90 feet thick, making surface mining techniques feasible. Strip mining in arid and sparsely settled regions of the West could cause extensive damage to fish and wildlife resources and their habitats. Impacts are also expected in the eastern coal fields where the

demand for surface and deep-mined coal is increasing rapidly.

The effect of increased coal extraction and processing on fish and wildlife is of major concern. Serious habitat loss could occur for migratory birds, resident mammals and birds, and threatened or endangered species due to direct and indirect effects of both coal extraction and processing. Numerous opportunities exist to minimize these losses in areas of intensive coal

development with well planned reclamation. After strip mining and reclamation, many of these areas could be managed for wildlife if fishery and wildlife resource information is included early in the planning process.

The Coal Project has initiated several major thrusts to better assure that fish and wildlife resource needs are adequately considered in the Federal decision-making process concerning coal development. Highlights of the current program follow.

- Studies on Ecological Test Areas will provide data on impacted ecosystems. The major portion of the Coal Project's resources was directed toward studies to develop the necessary background information on the ecosystems that would be impacted by coal development, and to develop better means of assessing and minimizing potential impacts. To implement an effective applied research and development program with large data analysis requirements, a structured biogeographic approach was developed. The approach, based on defined Ecological Test Areas, reduces the size and number of locations required for field studies. Although the Coal Project is national in scope, limited available resources dictated that initial efforts be concentrated on the western coal fields. Within the western United States, five Ecological Test Areas, averaging 5,000 to 10,000 square miles in area, were selected. Each area contains ecosystems currently or potentially under stress from coal development. These test areas are in southwest North Dakota, southeast Montana-northeast Wyoming, northwest Colorado, northwest New Mexico, and south-central Utah.

In selecting these test areas, consideration was given to plans for coal development, status of ongoing or planned studies by other agencies or groups, existence of data bases, and the natural boundaries of systems that might be affected by coal development. A preliminary "ecoregion" definition indicated that for the western area the five Ecological Test Areas fall within different major ecoregions. This was the first step toward an integrated approach to biogeographically relating habitats, wetlands, uplands, and resource development within a single meaningful structure. Similar test areas will be selected in eastern ecoregions under stress from coal development.

Detailed studies are underway on these test areas; greatest emphasis was initially on the Montana-Wyoming test area. These studies involve assembling all available background information on fish and wildlife populations and habitats by remote sensing methodologies and field surveys to obtain new information. The information is necessary to develop com-

puter-based information management systems, identify reclamation opportunities, and formulate strategies for influencing the coal development process to minimize the associated impacts to wildlife. The overall objectives of the study on the Ecological Test Areas are to biologically characterize fish and wildlife and their habitats that are currently or potentially under stress from coal development, and to assess, predict, and minimize coal related impacts to fish, wildlife, and their habitats.

based information to complement the site-specific Ecological Test Area activities. Twenty-five major efforts and activities (in-house and on contract) were initiated during this fiscal year. These activities were implemented in the following categories:

- Summaries of Existing Information
- Ecological Investigations
- Rapid Assessment Methods
- Information Management
- Wildlife Values

Results thus far have yielded information on existing ecological data and resource development, acquisition of existing and new aerial photographic coverage, and new information on fish and wildlife species within the test areas.

- A number of generic studies, not specific to individual test areas, are being conducted. These studies will provide broad

Examples of completed efforts include a biological approach to decision making entitled "Questions, Rules and Data (QRD)," published jointly with the Forest Service. Ecological sampling techniques were examined in the publication "Guidelines for Line Transect Sampling of Biological Populations." In addition, a "Tree Planting Handbook for the Dakotas" was

printed to enable interested parties to deal more effectively with given reclamation problems.

- The Coal Project has assured active Fish and Wildlife Service involvement in Departmental decision making concerning coal development. During FY 1976, the Coal Project staff participated in Departmental task forces and Secretary-level decision making on regulations for Federal coal leasing and operations. The staff also assisted in the definition of key terms such as "commercial quantity," "diligent development" and "areas unsuitable for mining," which will be significant in guiding Federal management of the program. Coal Project staff provided input to the Department's Energy Minerals Activity Recommendation System, which is responsible for decisions regarding the leasing of Federal coal lands for mining.
- To develop the capability to participate in coal operations at the Regional level, Regional Coal Coordinators were appointed in key western coal producing States. Located in Fish and Wildlife Service Regional and Area Offices, they will maintain awareness of the status of coal development and provide biological input into coal development procedures. Regional staffs have been working cooperatively with western State fish and wildlife agencies to identify areas of greatest and least priority for wildlife in potential coal leasing areas. This information is available to, and being used by, the Bureau of Land Management and State agencies for leasing decisions, and development of lease stipulations.

In addition, Service participants have been assigned to Department Teams currently preparing regional environmental impact statements to assure the best input of fish and wildlife information for the following coal regions: northwest Colorado; Sweetwater, Wyoming; west-central North Dakota; southern Utah; Northern Powder River Basin, Montana; and the Hanna Basin/Atlantic River, Wyoming.
- Efforts have also focused on planning and coordination of project activities. The Coal Project consists of a large and diverse set of activities and major efforts were made in developing long-term program strate-

gies. This resulted in the development of a report, "Five-Year Framework, Coal Project." Coordination of habitat mapping received particular attention. The project conducted an interagency workshop and published a summary report on "Environmental/Ecological Mapping Needs of the U.S. Fish and Wildlife Service."

Many of the projects underway in FY 1976 will be continued or completed in FY 1977; most of the ongoing studies are scheduled for completion before FY 1978. The Montana/Wyoming and northwest Colorado Ecological Test Areas will continue to have high priority for new studies to be initiated in FY 1977.

To date, most of the Coal Project's efforts have focused largely on western problems. However, with anticipated acceleration of eastern coal development, efforts in FY 1977 will focus increased attention on eastern problems. Towards this end:

- A Fish and Wildlife Service task force will complete its assessment of coal and other eastern mineral problems and recommend Service actions.
- An Eastern Energy and Land Use Group is being established at Harpers Ferry, West Virginia, to coordinate eastern studies.
- Regional operational capability will be strengthened to work with other Interior agencies in connection with eastern coal leasing activities.

POWER PLANT PROJECT

Federal energy planners expect that more than 350 steam-electric power plants will be constructed in the next decade. The land area used for electric power generation and transmission could triple by the year 2000, becoming equal in size to the combined land areas of the States of Maryland, Connecticut, Massachusetts, New Jersey, and Delaware; the water flow through the plants could be twice the combined discharge of the Mississippi, St. Lawrence, Columbia, Rio Grande, and Colorado Rivers.

The overall objective of the Power Plant Project is to develop and disseminate information relating to environmental impacts of electric power generation and transmission that will aid in the protection and possible enhancement of fish and wildlife resources. Within this framework two complementary objectives are being proposed: (1) to provide the capabilities to assess

and predict the biological implications of electric power development and (2) to assure that proper information is used in current and future decision-making processes.

The first objective includes the improvement of methodologies such as modeling, study designs, and quantification of ecological factors; and improvement of the information base available to Service and other biologists in the subjects of engineering, biology, laws and regulations, economics, and mitigation as they relate to electric power development. The second objective includes the development of methods and strategies for incorporating fish and wildlife protection goals into the planning and decision process and the promotion of environmentally sound alternative methods for producing and transmitting electric power such as mitigating environmental impact technologies, land management schemes, and optimum site locations.

At present, planners often do not adequately consider biological resources in power plant design and development because of a widespread lack of basic information. The Power Plant Project supports studies that result in the development of new strategies for power plant impact assessments. Guidance is given to scientists conducting environmental impact studies on proposed power plant sites. This assistance should help to streamline both the utility company's environmental assessments and the subsequent Federal review. Activities presently underway deal with:

- Problems arising from the use of water for power plant cooling. Aquatic impacts include the destruction of planktonic organisms as they pass through the plants' cooling system (entrainment); the loss of larger fish and shellfish that encroach upon cooling system intake screens (impingement); the degradation of ecosystems by modifying flow, salinity, and thermal regime of natural water bodies; and effects of toxic chemicals.

Mathematical modeling is currently the most common approach to predicting the impacts of power plants on aquatic populations. Because of Federal regulatory responsibilities to protect the environment and the difficulties of measuring environmental impacts, the use of mathematical models is likely to be adopted as a requirement of Federal regulatory agencies in all situations where power plants may impact important environmental

resources. The successful application of mathematical models to biological systems is very complex and requires the resolution of a number of issues including information deficiencies. Informational deficiencies are important because the reliability of any model is directly related to the accuracy of the data used.

Several studies have been funded to help alleviate the information deficiencies. The University of Tennessee is developing a three dimensional model for predicting power plant entrainment and impingement. The model will improve the Service's overall impact analysis through greater understanding of these two problem areas. The problem arising from density dependent processes has been largely ignored. A contract for computer simulation work in this area with the Virginia Polytechnic Institute and State University will provide insight into the little understood density dependent effects.

Accurate data on the susceptibility of the various life stages of fishes to entrainment and impingement are not currently available. Accordingly, a study undertaken by Virginia Institute of Marine Science will assess the precision and accuracy of equipment used for sampling larval fishes. Once samples are collected, the problem of correct identification of eggs and larvae must be recognized. As part of this effort, the synthesis of information on the egg, larval, and juvenile stages of fishes of the mid-Atlantic area is being done at the University of Maryland. Results from this study will enable faster and more accurate identification. Another problem associated with power plants concerns fish killed by power plant biocides, primarily chlorine. In response, a study is being conducted at the University of Maryland on chlorine toxicity to eggs and larvae of selected fish species.

During FY 1976 the National Power Plant Team continued its investigation of the impacts from power plant development on fishery resources dependent on the Hudson River Estuary and other locations.

- Management of electrical transmission lines is an associated problem to electrical power development. The Power Plant Project is supporting the preparation of a

technical assistance manual for management of transmission line rights-of-way to minimize damage to fish and wildlife resources. The manual will contain the necessary technical detail to enable formation and implementation of specific management plans in any geographic area in the United States.

wildlife resources associated with electric generation and transmission and will produce a report on the subject.

One project directed specifically toward improving the review of environmental impact statements is the preparation of a guide to mathematical models by Battelle Memorial Institute. This will be written for

The Virginia Polytechnic Institute and State University developed the POWER model which is a computer based technique to assist in locating utility corridor rights-of-way. This model enables a wide variety of factors, including environmental, to be considered in utility corridor siting decisions.

- Overall impact assessment techniques for power plants need to be improved. Summary reports and documents directed specifically at those in the review and decision-making process are being developed to assure that biological information will be utilized fully. Asplundh Environmental Services is analyzing decision-making processes affecting fish and

personnel with little or no experience with modeling techniques who need basic information on the appropriate application to power plant assessment.

The Biological Services Program also participated in the development of a Guidance Manual for the Environmental Protection Agency to assist in determining the effects of thermal pollution from power plants. The manual is scheduled for publication in FY 1977.

- The need exists for readily available information sources. The Fish and Wildlife Service has entered into an interagency agreement with the Energy Research and Development Administration to have the Ecological Information Center of Oak

Ridge National Laboratory compile several comprehensive bibliographies of technical information on selected aspects of the environmental impacts of electric power generation and transmission. These bibliographies will provide the basic references necessary to synthesize information on topics of concern.

Next year's activities will to a large extent involve a continuation of current studies. Among the ongoing projects is research directed at predicting the effects of power plant entrainment and impingement on larval fishes and fish population dynamics. It will focus especially on the manner in which aquatic ecosystems respond to this perturbation. A study to develop strategies for estimating the impact of power plants on fish and shellfish will result in a manual that can be used to initiate more efficient assessment procedures of impacts to aquatic life. The effects of coal combustion byproducts will be investigated and a major initiative to address these problems will be designed. To assist the Service's field units a series of "Topical Briefs" will be published which will provide concise, up-to-date information on a wide variety of topics related to electric power development and the environment.

HABITAT CLASSIFICATION AND ANALYSIS PROJECT

A basic step toward the evaluation, protection, and management of the Nation's fish and wildlife is the development of a system for classifying, inventorying, and evaluating existing fish and wildlife habitats. The Habitat Classification and Analysis Project was initiated in January 1976, to aid in developing and implementing such a system. The functional unit of the project is the Habitat Assessment Group, located in Fort Collins, Colorado, as part of the Western Energy and Land Use Team.

By June 1976 it was recognized that several ongoing functions and projects within Biological Services could be more effectively managed and their objectives more efficiently obtained if they were combined. As a result, the Biological Indicators Project and the Remote Sensing Coordinator functions were merged with the Habitat Classification and Analysis Project.

Four specific long-term objectives have been identified. The first is the development of comprehensive, ecologically based, hierarchical classification systems for all fish and wildlife

habitat of the United States and its principal territories, including territorial waters. Secondly, a cost effective method for inventorying fish and wildlife habitat, and transferring this method to users must be acquired. Thirdly, systems must be developed to quantitatively describe relationships of fish and wildlife resources to habitat, including use of indicator species to monitor habitat quality and effects of habitat changes on fish and wildlife; these systems must be made available to users. Lastly, a computerized geo-based system must be established for compiling habitat data and making useful information available for resource management decisions.

As the development of natural resources and land and water use increase, the threat of habitat destruction is certain to increase. The complexity of natural ecosystems often makes it difficult to clearly project the impacts in advance of development. A comprehensive system for classifying fish and wildlife habitat and a geo-based management system for habitat information will allow greater flexibility in assessing the regional impact of resource developments. The system can only be developed if a common data base and methodology exists for all impacted areas and resources.

The thrust of the Habitat Classification and Analysis Project is to ensure a common base for assessment of diverse impacts generated by resource development and other environmental modifications. The biological indicators portion of the project seeks to develop a reliable basis to assess the status of important habitat, ecosystems, and geographic regions. This information can include biological observations, phenomena, or measurements which either by themselves or in combination will reliably indicate the existence of, or changes in, a specific environmental condition. The remote sensing portion of the project eliminates some of the laborious aspects of habitat inventory, analysis, and monitoring. It is an effort to implement proven techniques and develop new ones.

Some of the current and ongoing activities of the project follow.

- The National Inventory of Biological Monitoring Programs was initiated as a cooperative effort between the Council on Environmental Quality, the Fish and Wildlife Service, the National Oceanic and Atmospheric Administration, and the Energy Research and Development Administration and has been completed. It included coding and verification of 1,021

programs and entry of the data into an on-line computer information retrieval system at the Oak Ridge National Laboratory. A printed manual version of the data base and index has been distributed to various Fish and Wildlife Service Field Offices for on-site use. Preliminary tests are in progress. Transfer of the file to the RECON system at Oak Ridge will make it accessible nationally.

- A second study involved development of a methodology for determining whether colonial nesting wading birds could be used as indicators of man-induced changes in coastal environmental quality. One hundred ninety-five colonies of birds have been located and surveyed along the Atlantic Coast. Species composition, numbers of individuals, reproductive success, and feeding and nesting habitat requirements were measured.

Preliminary results of this study suggested that wading birds might serve as predictive indicators as well as early warning indicators. That is, they could show not only that something was wrong, but also suggest what might be wrong. It seems possible that the requirements of the different species are such that changes in reproduction or numbers of one or more might identify portions of the habitat or ecosystem that were changing. This study is being conducted by the Patuxent Wildlife Research Center.

- National remote sensing coordination for the Fish and Wildlife Service is also a function of this project. Several important activities occurred this year. Two training courses in basic image interpretation were presented to approximately 40 Service personnel representing all the administrative regions and nearly all Service programs. These courses, prepared in cooperation with and presented by the staff of the Applications Assistance Branch of the Geological Survey's Earth Resources Observation Systems (EROS) Data Center dealt with the application of color infrared aerial photography and Landsat imagery to vegetative mapping for wildlife habitat analysis. Reviews received from graduates of the course indicate that the experience gained is relevant and immediately applicable to their responsibilities.

Liaison continued with the EROS program and with the National Aeronautics and Space Administration (NASA). Funds were obtained from the EROS program and transferred to Fish and Wildlife Service Region 1 to investigate mapping and monitoring of coastal eelgrass and kelp communities by digitally processed Landsat imagery. This information is useful in establishing the health of coastal environments. The staff continued to represent the Service on NASA's Ocean Dynamics Advisory Subcommittee. Initial plans were formulated to test the applicability of certain Fish and Wildlife Service geophysical data from the new satellite SEASAT-A to the Service's data requirements in the Arctic.

Projects initiated during 1976 will continue. The conceptual framework for comprehensive, hierarchical, ecologically-based, national classification systems for fish and wildlife habitat will be developed, as will specific elements of these classification systems relating to coastal and riparian habitats.

The project will survey, consolidate, and incorporate extant information on indicators of habitat conditions into the national system of habitat elements. Analysis of extant indicators data, and synthesis of information dealing with long-term biological trends within characteristic habitat types will be undertaken to determine reliable indicators for monitoring habitat status. The adequacy of the indicators will be evaluated and areas of further work will be identified to meet Fish and Wildlife Service needs.

Furthermore, a survey of existing geo-based information and composite mapping systems, and initial recommendations for a system or systems to meet the goals of the project will take place.

NATIONAL WETLAND INVENTORY PROJECT

The loss of habitat is the most serious threat to wildlife in the United States today. Wetlands are vital nursery areas for many forms of wildlife, yet marshes, fens, bogs, and swamps across the Nation are being drained and modified at an alarming rate. The need for a national survey of remaining wetlands was recognized several years ago and preparations for operational mapping were begun in 1975.

The last National Wetland Inventory was completed in 1954 and surveyed only the contiguous 48 States. This inventory was related primarily to waterfowl values. Considerable wetlands modification has since occurred. In addition, the importance of wetlands to other elements of man's biological and physical environment is more widely appreciated, and a better methodology exists for classifying and inventorying this resource. The new inventory, reflecting these changes, is expected to be completed by the end of FY 1979. A new classification system will be used in the inventory to improve the definition of wetlands for planning purposes.

The overall design of the inventory allows for periodic updating, which is particularly important for those areas where population, industrial, and agricultural pressures are greatest. The Analytical Photogrammetric Positioning System, first developed for military use, is being modified, adapted, and tested for use in the project. The total system, with additional storage capacity, computer, and digitizing equipment, is expected to allow the inventory of wetlands to be conducted with less logistical error, reduced time requirements, and greater locational accuracy.

of 1:24,000 will be produced. When possible, the inventory will incorporate recently performed State and local wetland surveys. The work will be performed by Federal and State agencies and private contractors.

All information gathered for each wetland, as displayed on the map series, will be digitized and stored in a National Wetland Inventory computer data bank. Each wetland will be located by geographical coordinates, physical subdivision and ecoregion, major watershed, flyway, State, county, and census district. This information can then be retrieved and manipulated by the user to produce either tabulated printout sheets or computer maps at any scale.

Regional and national reports will summarize the findings of the inventory in each Fish and Wildlife Service Region and for the entire country. They will include tabulations of data by wetland type, political division, and natural physical division (such as ecoregion, flyway, and watershed). Specific activities and accomplishments of this project are discussed below.

- An interim wetland classification system was completed during FY 1976 and

The National Wetland Inventory map series will display wetlands classified according to the recently developed wetland classification system at a scale of 1:100,000. In areas congested with a large number of small wetlands, as in the Florida karst terrain or the prairie pothole region, maps

published in a report entitled "Interim Classification of Wetlands and Aquatic Habitats of the United States." The system is being tested at 22 field sites throughout the country.

- An index showing the location of good

quality, high altitude aerial photography was compiled and is available ("Index of Selected Aerial Photography of the United States").

- An inventory entitled "Existing State and Local Wetland Surveys (1965-75)" was completed and published. These surveys may be incorporated into the national inventory.
- A series of maps, of the entire United States at 1:250,000 scale, displaying physical subdivisions, land surface form, and ecoregions has been produced.
- A review of State and local wetland laws and ordinances is being compiled in conjunction with the Environmental Law Institute. A National Wetland Protection Symposium will be held in June 1977 to discuss wetland protection efforts.

The National Wetland Inventory Project will become operational during FY 1977, with mapping starting in Florida. Inventories will be initiated for most of the U.S. coastal zone along with selected prairie pothole and Mississippi Delta regions during FY 1977. The remainder of the United States will be completed in FY 1978 and FY 1979.

INFORMATION TRANSFER PROJECT

One of the main thrusts of the Biological Services Program is the application of relevant information and research findings to ecological problem solving. Provision for the transfer and utilization of the information and technology it develops is integral to the Program's approach. To promote application of the Program's findings a coherent information and technology transfer strategy is required. The Information Transfer Project assists in developing and implementing such a strategy, as described below.

By gathering ecological data, sponsoring applied research, synthesizing results, and providing technical assistance, the Biological Services Program addresses needs in key areas of ecological concern. To assist with identifying and satisfying these needs, the Information Transfer Project develops appropriate information transfer strategies and techniques for application through the Program, and plans and manages an information transfer network consisting of people, organizations, functions, procedures, equipment, and information resources. This approach provides a logical basis for strengthening information transfer processes

that would otherwise occur in an informal, ad hoc, and inconsistent manner.

A discussion of the steps taken during FY 1976 to develop and implement the information transfer network and associated information transfer strategies and technology follows.

- An Information Transfer Specialist, with expertise in information science, was placed on each National Team and at the Office of Biological Services headquarters. Computer terminals and telecommunications equipment were installed at all sites. Training in the information transfer network operations was initiated, and development of formal network procedures continued.
- Major available data bases were identified; access arrangements were made for more than 50 data bases on several on-line, time-sharing computer systems; and information retrieval services were provided to Service field personnel and other users.
- To increase communication between field staff in performing their operational functions and the National Teams in identifying and responding to needs, the Biological Services Program provided information transfer assistance to four Ecological Services Field Units on an experimental basis. Early results indicate that there is a strong potential for strengthening the ability of the field staff to utilize improved information services to better formulate and evaluate alternatives to proposed land and water development.
- With contractual assistance, an analysis was made of the Program's need for policy standards and procedures for planning, preparing, reproducing, and disseminating printed products. A manual entitled "Communication Standards and Procedures" was developed which provides "how to" information for producing usable products and presents a wide range of strategies for disseminating information to various types of audiences. It is currently being field tested with the staff at the Office of Biological Services Headquarters, the National Teams, and the Regional Activities Leaders.
- Information retrieval and dissemination requirements of the information transfer network were analyzed, and a 5-year plan for development and implementation was

outlined. The study provided insight into some of the capabilities needed to fully implement the information transfer system.

- An interagency arrangement with several Federal agencies was established to support and guide the Corps of Engineers in the development of an on-line Sensitive Species Information System. Coordination, guidance, and funding for system development is provided by the Information Transfer Project; input quality control and funding by the Office of Endangered Species; and species selection, funding, and advice by other participating agencies. When operational, the system will be accessible nationally for on-line retrieval. It will also be used as a source for various publications and maps locating the ranges of selected species.
- Preliminary planning was initiated for expanding the information transfer network. Information and technology transfer units are planned to be established in Fish and Wildlife Service Regional Offices in FY 1978. This expanded network is expected to form the basis for a national system of shared data bases and related information transfer services to support fish and wildlife related resource management and development. The potential of cooperative arrangements with the States is also being explored.
- To maximize the effectiveness of Fish and Wildlife Service comments on proposed resource developments, such participation should occur early in the planning process. A pilot Activities Alerting Information System was designed for coastal regions along the Gulf of Mexico. If implemented, it is expected to provide early warning signals to appropriate Service field people regarding planning that could have a significant environmental impact on their areas of concern. The field people will then have more time to provide information and recommend alternatives so that fish and wildlife values are considered more fully in the development process.

Development of data base structures, guidelines, and monitoring procedures, and selection of computer systems will continue to receive high priority. These areas of network development are fundamental to achieving an efficient

network of shared data bases and related information transfer services in support of environmental impact assessment and natural resource management.

Efforts to identify opportunities for interagency data bases, such as the Sensitive Species Information System and the National Biomonitoring Information System, will continue. Such interagency cooperation is essential to building a national information base on fish and wildlife and supporting ecosystems.

A new emphasis will be placed on operations analyses and strategic planning to determine the effectiveness of planning, management, delivery, and monitoring systems. Analysis of user feedback and training of Information Transfer Specialists and Regional Activities Leaders in information transfer processes will receive increasing attention.

COASTAL ECOSYSTEMS AND OUTER CONTINENTAL SHELF DEVELOPMENT PROJECT

Activities of this project involve analysis of environmental problems affecting the Nation's coastal and marine systems, including the various effects of Outer Continental Shelf (OCS) minerals development.

For the past 20 years, the Federal leasing of submerged lands on the Outer Continental Shelf for oil and gas development has been confined chiefly to the Gulf of Mexico and, to a lesser extent, southern California. In 1974, the Department of the Interior announced an acceleration of OCS leasing as part of the new Federal energy policy, with plans to offer sales in "frontier" coastal areas along Alaska, southern California, and the Atlantic Coastal States, as well as additional areas in the Gulf of Mexico.

Fish and wildlife habitats may be altered both onshore and offshore during oil and gas development. Some of the environmental impacts are known as a result of activities in the Gulf of Mexico, where there are presently about 2,300 offshore platforms. Direct onshore damage, for example, may result from digging canals to float drilling platforms (constructed on land) out to sea and from digging trenches for pipelines to transport oil and gas from offshore wells. These practices have led to saltwater intrusion and increased erosion of coastal lands. Moreover, major losses of fish and wildlife habitats may occur in the siting of refineries, tank farms, transportation facilities, and in the growth of new

communities for workers—all of which require many thousands of acres of land.

The project seeks to develop a strong ecological information base that will permit managers to better assess coastal resources and the impact of many ongoing activities.

Outer Continental Shelf Development Activities

The Fish and Wildlife Service was given a stronger role in the planning and operating functions of the OCS minerals program under a recent Order of the Secretary of the Interior. Under the Order, the Service provides the Bureau of Land Management with advice on overall environmental research and monitoring program design; performs or manages certain elements of the studies; monitors study elements of special interest to the Service, and participates as a member of the OCS Technical Proposal Evaluation Committee. The Service also provides fish and wildlife resource information on prospective lease areas to the Bureau of Land Management, makes recommendations on tract selections, and assists with the development of lease stipulations, the planning of pipeline alignments, and the design of biological sampling and monitoring programs for lease development stipulations. In addition, the Service provides information for environmental impact statements, OCS orders, regulations, and proposed legislation. It makes recommendations on the installation of pipelines, platforms, and other structures needed for exploratory drilling. Several major activities in implementing the Secretarial Order were conducted.

- Through the project, the Fish and Wildlife Service participated in activities related to five sales. The Bureau of Land Management held five oil and gas lease sales: two in the Gulf of Mexico; one in offshore Southern California; one in the Gulf of Alaska; and one off the mid-Atlantic States. Widespread environmental concern was expressed over the sales in the frontier areas. Both the Southern California and Gulf of Alaska lease sales contained a number of tracts of particular importance to fish and wildlife and their habitats. The Service supplied resource information and offered recommendations concerning the deletion of tracts from these sales for the purpose of protecting the environment. Many of these recom-

mendations were accepted and were instrumental in reducing the size of the Southern California and Gulf of Alaska lease sales.

- Because of the Service's involvement in the OCS leasing process, procedures were drafted to instruct Fish and Wildlife Service personnel on their role with respect to research, monitoring, and operational activities related to the OCS. It is expected that the procedures will be fully implemented in FY 1977.
- In addition to the sales that were held in FY 1976, the Fish and Wildlife Service was involved in supplying resource information and offering advice for OCS oil and gas lease sales scheduled to be held off the North and South Atlantic coasts, the Gulf of Mexico, Gulf of Alaska, and the Lower Cook Inlet. These sales were scheduled to be held during FY 1977.
- The Fish and Wildlife Service is also being represented as an ex-officio member of the OCS Environmental Studies Advisory Committee. Activities with the Committee have included the review and evaluation of Bureau of Land Management Environmental Study Plans, as well as participation in quarterly meetings with representatives of other Federal agencies and the coastal States.
- The project has also been involved with oil and gas related development on shore. Information has been supplied and recommendations have been made concerning Petroleum Reserve No. 4, the Trans-Alaska Pipeline, the Arctic Gas Pipeline, oil development on wildlife refuges in Alaska, and exploratory operations in the Canadian Beaufort Sea.

Coastal Ecosystems Activities

The project has undertaken activities which will provide relevant information on fish and wildlife to development and planning activities in the coastal zone. The focus is on providing information relevant to action programs, primarily the responsibility of State and Federal agencies, designed to control development and otherwise protect living resources. Interests range from regional multi-state coastal zone planning to site-specific permit review for wetland modifications. The primary purpose of the project is to support and supplement such operational efforts by developing impact assess-

ment methods and an ecological information base. Activities designed to achieve the objectives of the project follow.

- The project is developing new approaches to characterize important coastal ecosystems through the compilation and interpretation of existing data. Products include maps portraying the distribution of living natural resources, tables, graphs, models, and narrative reports emphasizing the values and relationships of fish and wildlife resources within the ecosystem. The initial pilot effort in developing this approach is an ecological characterization of the Chenier Plain of southwestern Louisiana and southeastern Texas.
- Marine Bird Studies constitute a second major thrust of the Coastal Ecosystems Project. These birds are particularly vulnerable to impacts resulting from human coastal development including potential oil spills from drilling on the Continental Shelf. Two groups of studies are underway: surveys of marine bird populations designed to identify coastal areas of particular importance and in need of special protection, and studies of oil toxicity.

A major marine bird study is underway as part of the Alaska Outer Continental Shelf Environmental Assessment Program being conducted by the National Oceanic and Atmospheric Administration with funding from the Bureau of Land Management. Fish and Wildlife Service activities include ship and aerial censuses over tens of thousands of square miles to catalog Alaska seabird colonies and to determine seasonal distribution of marine birds in Alaskan OCS waters, migratory routes and patterns of distribution for marine birds in coastal and marine waters, and population levels of selected species. As suspected, preliminary results indicate the presence of a vast resource about which little is known. Over 100 million birds use Alaskan waters, and nesting colonies are scattered over the Alaska coastline of more than 34,000 miles. Offshore leasing for development of potential petroleum resources has been scheduled for nine frontier areas of which one or more are located in each of the four major oceanographic regions bordering the South.

To get an indication of the magnitude of the resource in other coastal areas, several

pilot projects were started in OCS waters on Georges Bank and the mid-Atlantic area. Again, preliminary results indicate a vast resource about which little is known and for which there is insufficient information to evaluate the magnitude of the impact should disaster occur during OCS oil and gas development.

Colonial sea and wading bird colonies along the Atlantic coast, the Gulf of Mexico, and the Great Lakes shores were located and populations estimated. Information has been forwarded to Fish and Wildlife Service field offices for use in review of permits for proposed modifications in navigable waters. The same data are being used to evaluate spoil disposal schedules for Corps of Engineers maintenance dredging.

The information was provided to several Federal and State agencies for use in updating resource base maps and for identification of sensitive habitat.

- The disastrous effects of oil spills on marine birds are well known; however, little is understood of the subtle or chronic effects of low level oil contamination. Therefore, a study was begun at Patuxent Wildlife Research Center to determine the fate and effects of ingested hydrocarbons and the effect on embryos of oil-contaminated eggs. The current year was spent primarily in testing and adapting analytical techniques for investigating hydrocarbons in bird tissues. Experimental mallards and eider ducks exhibited a number of abnormal responses ranging from acute toxicity of developing embryos to more subtle changes in liver metabolism. Minute amounts, as little as one microliter (34 millionths of an ounce), of both crude and refined petroleum when applied to the surface of an egg resulted in the death of the embryo, usually within 72 hours. Eggs in the early stages of incubation were especially susceptible. If incubating adult birds were to come into contact with spilled oil, this could represent a potential for contamination of the eggs.
- Other important coastal ecosystems or populations are being studied as well. An ecological description of six California estuaries, complementing State efforts to describe all of California's estuaries, has been completed and the reports are available.

The National Fish and Wildlife Laboratory is preparing detailed life history information and habitat requirements for endangered species occurring in the coastal areas of the southeastern United States. This report will identify threats to and habitat requirements of endangered species for appropriate consideration in activities controlling coastal development. The availability of information on endangered species early in the planning cycle should avoid later delays and confrontations, and minimize the threats to these species.

Seagrasses, the meadows of the sea, are being heavily impacted by numerous coastal developments and projects. Since seagrasses are highly productive, supporting many organisms and providing habitat for many others, there is concern about the continued reduction in seagrass

communities. The first phase of a study underway is aimed at synthesizing existing biological and management information germane to the protection of seagrass ecosystems. Additional effort is underway in cooperation with the Environmental Protection Agency and the State of Maryland to perform a similar but more detailed synthesis of information about the value of submerged aquatic plants to fish and wildlife resources in the Chesapeake Bay.

- A number of studies are also underway to develop better approaches for assessing and minimizing the ecological impacts of coastal development. For example, a study by the Conservation Foundation will result in a handbook to improve the Service's capability to analyze the effect of onshore, nearshore, and marine impacts of OCS oil and gas development on fish and wildlife resources. The report and accompanying appendices will be useful to other Federal and State agencies as well as industry in planning and assessing impacts of offshore development programs.

Another report is being prepared to describe the long and short term effects on fish and wildlife of various structures commonly constructed in estuarine environments. Alternative measures to mitigate adverse impacts will be included. The study is scheduled for completion in October 1977.

A comparison of the history of oil and gas development activities on private and public lands (especially refuges) is underway which will provide methods and standard recommendations to protect fish and wildlife resources. Emphasis is presently being placed on the northern Gulf of Mexico coast because of its long history of such activities. A similar analysis is planned for portions of Alaska. Reports are scheduled for next year.

The Coastal Ecosystems Project is also involved in an interagency study to develop guidelines for coastal floodplains management. The effort is designed to provide planning guidance to State and local authorities, and is being coordinated by the Council on Environmental Quality.

- Project personnel have also played an active role in training, technical assistance, and other activities relating to

coastal ecosystems. The University of Georgia Marine Science Institute hosted a Marsh Development Workshop sponsored by the Biological Services Program in May 1976. The Workshop provided Fish and Wildlife Service biologists an opportunity to become familiar with the latest techniques of marsh development and rehabilitation. Numerous experts from across the Nation presented the results of their research. These papers will be available for distribution in FY 1977.

The Third Biennial International Estuarine Research Conference on Recent Advances in Estuarine Research was held in October 1975, in Houston, Texas. The conference focused on twelve topics relating to the use and functioning of estuaries and coastal areas. The topics summarized recent advances, evaluated emerging problems and current concepts, and stimulated exchange among scientists, managers, and others interested in estuaries or coastal areas. The Proceedings, in two volumes, is entitled *Estuarine Processes*, and published by Academic Press, 1976.

Biological Services staff members were actively involved in the planning and organization of the Environmental Protection Agency Conference on Estuary Pollution Control held in Pensacola, Florida, on February 11-12, 1975. The purpose of the conference was to further develop materials dealing with the status of estuary uses, pollution, and management which were vital to the preparation of EPA's Estuary Report to Congress.

- The first North American Wading Bird Conference, cosponsored by the U.S. Fish and Wildlife Service and the National Audubon Society was held in Charleston, South Carolina, on October 14-17, 1976. The conference facilitated the exchange of ideas and served to identify common problems and topics for needed research.

Involvement in OCS development will be expanded in FY 1977 as necessary to keep pace with the Department's leasing program. Pursuant to the Secretarial Order, fish and wildlife resource information will be made available to the Bureau of Land Management for use in the OCS leasing process.

The current coastal ecosystems study program will be expanded by three more ecological

characterizations in the coastal areas of southeastern United States, New England, and the Pacific Northwest.

Participation of Biological Services staff in a couple of important workshops is planned. These include:

- The Fourth Biennial International Estuarine Research Conference, to be held October 3-5, 1977. The conference, as presently conceived, will include discussion of estuarine development and resource management, estuarine communities and ecosystem relationships, land-estuary interactions, and estuary-nearshore interactions. Proceedings will be published in FY 1978.
- An Oil Spill Response Workshop to be held early in FY 1977 to improve the capability and effectiveness of the Fish and Wildlife Service in responding to oil spills. Cosponsored by the Office of Biological Services and the Office of Migratory Bird Management, the program will consist of an exploration of the biological and physical impacts of oil spills; an overview of techniques available for coping with spills; a sharing of views and concerns among representatives of private, State and Federal organizations; and a critique of the recently drafted Fish and Wildlife Service oil spill contingency plan. Proceedings will be published in FY 1977.

With many of the products of the initial study efforts now becoming available, major future thrusts will be to transfer the information in forms that will make it widely available and useful to decision makers. This will involve increased use of training courses, workshops, and other mechanisms.

STREAM ALTERATIONS PROJECT

Thousands of miles of waterways running through floodplain ecosystems—the most biologically productive inland habitats in North America—are being altered each year by Federal, State, and local government agencies. The alterations include channelization, impoundment, bank stabilization, gravel and sand mining, dredging, and construction of bridges, dams, and locks.

Much of the work has been done for flood control, to improve drainage from farmlands, to maintain and improve navigation, and for high-

way drainage. Channelization involves realignment of the streams and reshaping of the stream bed and stream bank to provide discharge capacity greater than that of the natural channel. In addition to the degradation and destruction of habitat along the natural course of the stream, sections of the stream are cut off, filled, or dewatered as the result of realignment or relocation of the channel.

When it is desired to increase drainage into the stream from adjacent lands, especially from farmlands, channelization normally includes lowering the stream bed profile. Extensive clearing of vegetation from the stream banks and the floodplain, reshaping the banks, and stabilizing them through riprapping and seeding with grass are frequently a part of channelization. Unfortunately, many fish and wildlife habitats are lost in the process.

Various studies are being conducted to help eliminate or mitigate the often highly disruptive effects of stream alteration on fish and wildlife and their habitat. One goal is to produce information that will enable construction agencies to give adequate consideration to fish and wildlife. Another goal is to develop methodologies for use by biologists and engineers in assessing the impact of channelization on biological resources.

Some of the specific activities of the project follow.

- During FY 1976 a series of initial studies on various aspects of channelization, principally on smaller streams, was completed. Reports on three of these initial contract studies for the States of Iowa, Mississippi, and Montana have been printed and distributed. Reports on the remaining six initial channelization studies, North Carolina, Ohio and Indiana, Vermont, Virginia, Utah, and Wisconsin, will be printed and distributed during 1977 and early 1978. The findings of these initial studies will be summarized in an overall assessment report which should prove useful to personnel involved in recommending or reviewing channelization activities.
- The project continued to broaden its initial fishery oriented studies to include wildlife and riparian habitats. The emphasis is shifting from comparing populations of animal and plant species in natural and modified streams to a broader considera-

tion of the habitat which supports fauna and flora. The studies are attempting to show the relationships among water regimes, habitats, and species. These relationships are important because even slight changes in the water regime can cause significant changes in growth patterns and composition of plant communities which in turn result in changes in the numbers and types of animals using the habitat.

- A two-pronged approach to vegetative studies has been mounted. The first approach involves synthesis of the literature and other existing information on the effects of water level management on riparian vegetation, primarily bottomland hardwoods. The second approach involves field assessments of impacts on riparian and aquatic habitat. One of these field studies operates under a cooperative agreement with the U.S. Geological Survey to develop a model for relating hydrologic regimes to growth and mast production in bottomland hardwood forests.

Other studies underway in Oklahoma and Iowa will relate changes in land use practices to the loss or degradation of riparian habitat. A study being conducted in Missouri addresses the floral and faunal changes in a lowland hardwood forest riparian habitat resulting from channelization, drainage, and impoundment. Results from this study will provide valuable information on the impact of these stream alteration practices on fish and wildlife resources in riparian and aquatic habitats.

- Work on stream alteration problems on larger river systems is underway. A study effort in cooperation with the States of Iowa, Nebraska, Kansas, and Missouri, and supported by the Army Corps of Engineers, will investigate the environmental aspects of bank stabilization and cutting notches into dikes and levees. This innovative study will evaluate the effect of periodically opening dikes and returning water to flood plains that have been cut off from the nourishing effect of flood waters along larger rivers such as the Missouri. Results are expected to contribute additional information on the effects of changes in the water regime on riparian habitat. Additional studies are investigat-

ing the effects of side-channel openings on the sloughs and backwater areas of a larger river system, developing habitat type maps of the Upper Mississippi through aerial photographic techniques, and determining the complex relationships between flooding, sedimentation, and the flora and fauna in the Atchafalaya Basin in Louisiana.

- A major multi-year contract study is underway in Alaska on the effects of gravel removal from arctic and subarctic streams on fish and wildlife. The objective is to provide information guidelines which will assist resource managers in minimizing the detrimental effects of this operation.
- Several activities to promote the use of stream alteration information were undertaken. The National Stream Alterations Team has led an information transfer pilot effort in Vicksburg, Mississippi.

To date, considerable progress has been made in providing technical assistance to the field personnel. The Team's hydrologist has been especially useful to the Vicksburg office, along with other Ecological Services offices, in assisting in the development of plans for structural measures in the restoration of the Kissimmee River, Florida, and in the development of study plans on the effects to fish and wildlife of a Army Corps of Engineers' proposal for navigation on the Apalachicola River.

The Fish and Wildlife Service cosponsored two workshops to exchange information. The first was the Stream Channel Modification Symposium held in Harrisonburg, Virginia, during August 1975. Over 250 persons attended this symposium to exchange ideas and promote cooperative working relationships on channelization problems. The second was a 2-day workshop held cooperatively with the Corps of Engineers, the Environmental Protection Agency, and State Fish and Wildlife Agencies in January 1976 in Kansas City, Missouri. This meeting dealt with proposed and ongoing studies of channel modification in the Missouri River Basin.

- Other activities in FY 1976 included a reconnaissance study of Hawaiian streams; participation by the National Stream Alterations Team Leader as a

consultant to the Quebec Government on the James Bay Energy Corporation's massive hydroelectric project; cooperation with the National Wildlife Federation in negotiations with the Federal Highway Administration regarding the problem of wetlands drainage in connection with highway construction and maintenance; development of a study proposal at the request of the National Park Service on the effects of upstream erosion and Redwood timber harvesting practices on downstream fish and wildlife resources in Redwood Creek, Redwood National Park, California; and the development of a special one week short course in hydrology for Ecological Services biologists given by the U.S. Geological Survey at their Denver Training Center in February 1977.

Future plans call for continuation of studies currently underway. Results of completed studies will be synthesized and summarized into usable products such as guidelines and manuals. Seminars, workshops, and training in subjects related to stream alterations will be sponsored or conducted. The Fish and Wildlife Service will cosponsor a coolwater fishes symposium scheduled for the North Central region of the United States in 1978. Plans are being developed with the National Wildlife Federation and the Federal Highway Administration for workshops on the problem of highway construction and maintenance and wetlands drainage in selected key problem regions. Seminars on various aspects of riparian habitat problems are in early planning stages.

WESTERN WATER ALLOCATION PROJECT

Diversion of water from streams and rivers poses one of the greatest threats to fish and wildlife in the water-short West, especially at this time in the face of severe regional drought conditions. In the allocation of water under western State water law, the Nation's fish and wildlife generally have not been considered "beneficial" users. As a result, water is frequently allocated to "higher" priority users until a stream is reduced to a trickle and is unable to maintain a viable fish habitat.

Over the years, numerous projects have been constructed to irrigate lands, provide flood protection, generate electric power, and provide

domestic and industrial water supplies. Competition for the limited remaining water is expected to be intense during the next decade, primarily because of the increased demands from both energy development and land reclamation.

The project is directed to the development of the necessary methodology, research base, data banks, and in-house professional expertise to understand the instream needs of fish, wildlife, and associated ecosystems. Better understand-

Water allocation decisions made in the next few years will have major long-range implications for fish and wildlife. Biological resources should be considered in decision making. To assure adequate consideration, the Western Water Allocation Project is conducting studies designed to supply three types of information: technical, current planning, and broad management.

On the technical level, the project is concerned with methodologies for determining instream flow needs for fish and wildlife maintenance, the location and habitat requirements for endangered species, and the effects of various developmental alternatives. On the current planning level, efforts are underway to identify strategies by which fishery flows can be reserved, to establish fish and wildlife priorities for individual rivers and streams on a selected basis, and to determine the water quantity needs of fish and wildlife in energy development areas. On the broad management level, new and emerging development areas are being identified so that appropriate and timely information can be supplied to planners working on future projects.

ing the needs will help ensure that living resources are given full consideration in planning and decision-making processes affecting water allocation and use. This effort is also concerned with the identification of techniques to provide for fish and wildlife habitat in conjunction with water intensive energy development.

Several important activities were conducted in FY 1976.

- A Cooperative Instream Flow Service Group, composed of seven professionals, has been established in Fort Collins, Colorado, as part of the Western Energy and Land Use Team. The Group is a multidisciplinary team designed to provide a focal point for the instream flow assessments. The group will have the major responsibility for providing technical input to contract studies and subsequent information transfer activities, and is working actively to provide advice and technical assistance to a number of State and Federal agencies. Three closely coordi-

nated areas of instream flow needs will be addressed: The biological, physical, and decision-making components. Constant interaction and feedback between the components of the group will assure that biological and recreational investigations result in relevant recommendations and that decision-making strategies are based on sound ecological and hydrological principles.

Specifically the group frequently interacts with professionals to disseminate important information dealing with current activities, new methodologies, research, and recent legal opinions. Training in instream flow methodology application and use, and in legal defensibility of recommendations resulting from new methodologies is being provided. The group is developing plans to maintain a series of instream flow methodology handbooks, a computer based storage and retrieval system for relevant and current instream flow research data, methodologies and materials, and a list of active practitioners in the field.

- The understanding of environmental impacts from water resources planning was increased through studies that measured actual effects on fish and wildlife from completed water resource development projects in the Pacific Northwest, California, and the Rocky Mountain Region. These studies show the effectiveness of pre-project impact projection techniques. Along these same lines, an analysis was performed to assess the adequacy of various methods used to predict low flow effects on fish and wildlife. The analysis uses an instream flow model now being tested and used as a training tool by the Instream Flow Service Group. This model is somewhat unique among biological management tools in that impacts are assessed for different rates of water withdrawal. The model explicitly recognizes that after a certain point (if not immediately for some streams) impacts are a non-linear function of water withdrawn. The model should be valuable for identifying potential problems early in the planning stage, before they materialize. It can be used to help identify those streams in which withdrawals would pose significant problems.

Another study, conducted by Utah State University, documents and evaluates current instream flow methodology techniques for fisheries, wildlife, water quality, recreation, and aesthetics. Through a concentrated effort of specialty and interdisciplinary workgroups, the state-of-the-art report entitled "Methodologies for the Determination of Stream Resource Flow Requirements: An Assessment," represents the most comprehensive and definitive compilation of methodologies available at this time. Nearly 2,000 copies of the report have been requested.

- A stream evaluation study is underway to establish priorities for critical stream areas in the West. Emphasis is to establish the current status of fish and wildlife in relation to existing water, the potential fish and wildlife values of these waters, and ranking of waters according to fish and wildlife values. These priorities will be used as the basis for selecting pilot river basins to be used to test various evaluation methods of possible impacts from energy development in areas near high priority streams.
- A study to determine the distribution and habitat requirements of endangered fish species in high potential energy development areas is also underway. Through the study, primarily centered around the upper Colorado and upper Missouri River Basin, mechanisms will be developed to identify, locate, and monitor endangered species in regions under stress from energy development.
- A study is underway in eastern Washington to determine the long-term habitat improvement features, such as configuration of cultivation, providing fence rows, drainage marshes, permanent canals, and off-channel reservoirs, of large irrigation development projects. Cosponsored with the Bureau of Reclamation, Washington State Department of Fish and Game, Washington State University, and the U.S. Office of Water Research and Technology, the study is an interdisciplinary evaluation of habitat improvement features and their associated economic cost, sociological impacts, and political implications.
- A major effort funded by the Water Resource Council using Energy Research and Development Administration funds

was started in 1976 to determine the Service's role in dealing with water assessments relating to energy development. As the next step of this process, the Water Resources Council has contracted with the Service to develop the methodology for determining instream flow needs in water assessments as required under Section 13 of the Federal Non-Nuclear Energy Research and Development Act. This study will develop adequate methodologies and define the data base required for determining instream flows that provide for the protection and propagation of fish, shellfish, and wildlife.

- Two major workshops were sponsored, for purposes of long-term problem assessment. A forum conducted by Resources for the Future on the "Impact on Western Water, Fish and Wildlife of Energy Development in the Upper Colorado River Basin" was held during October 1976. The major objective of the forum was to begin work on a document identifying and assessing the needs and problems of fish and wildlife from energy development related water allocation decisions in the Upper Colorado Basin. The final report will be available in spring 1977. A companion effort, completed by the University of Colorado, was an interdisciplinary effort that evaluated alternative energy development scenarios in the Upper Missouri River Basin, assessed potential fish and wildlife implications, and proposed research priorities. A final report entitled "Fish and Wildlife Implications of Upper Missouri River Basin Water Allocation" has been published.

The Fish and Wildlife Service cosponsored an Instream Flow Symposium at Washington State University from May 3 to 6, 1976. The objective was to bring together for the first time the three professional groups most involved in the setting and implementing of instream flows—biologists, hydrologists, and lawyers. These groups typically have acted unilaterally in an arena where the actions of each affected the others. Symposium participants took part in a series of short courses, panels, and round table discussions. Proceedings are available from Editor, American Fisheries Society, Bethesda, Maryland.

- A study to identify legal and administrative mechanisms to reserve stream flows for fish habitat has been partially completed with two reports already available. One deals with existing strategies for reserving stream flows and contains a preliminary evaluation of the implementation potential for each strategy. The other report identifies Federal reservoirs with unobligated water in storage, which may be available for release to enhance downstream fish habitat. The final product will be a detailed report for decision makers in which the strategies, outlining costs, relative effectiveness, and procedural guidelines are interrelated.

Future efforts will include a study, coordinated by Region 6 of the Fish and Wildlife Service to determine resource maintenance flows for critical streams through the West. The Cooperative Instream Flow Service Group will continue its activities designed to improve procedures for establishing biological requirements for instream flow and to develop communication links for this information to those making water allocation decisions.

Methodologies will be developed for assessing the impact of flow modifications in large rivers on fish. Because the current drought conditions in large areas of the West are serious, studies are proposed to document the actual conditions in large rivers throughout the affected area to better determine impacts on fish. Another study will be undertaken to identify and evaluate opportunities for using lower quality water supplies to revitalize wetland areas (marshes) or even to create new wetland areas.

A study will begin to evaluate using existing natural and artificial small water sources, such as springs, stock watering troughs, and guzzlers, to maintain fish and wildlife in arid areas.

Public information materials will be developed to show how fish and wildlife demands for water are part of the overall total water use pattern. Two areas to receive specific attention will be instream flow requirements and drought.

GEOHERMAL, OIL SHALE, AND MINERALS PROJECT

This project is concerned with the ecological effects of the ever-increasing efforts going into extracting terrestrial energy and mineral resources (other than coal). As the stock of high-grade mineral resources is depleted over time, pres-

tures increase to extract lower-grade, more extensive deposits of these resources, or to tap substitute products in new regions. Bringing these new resources into the economy entails disrupting large geographical areas, often in remote and previously untouched sections of the country. Thus, competition between resources extraction and fish and wildlife habitat can be expected to increase greatly, requiring the development of more intensive management and policy tools. The following discusses the individual activities in response to these new challenges.

Geothermal Activities

Development of geothermal resources for both electrical and non-electrical uses is being accelerated in the United States. Compared with other energy sources, geothermal energy potentially offers one of the most environmentally compatible sources of energy known today. For example, if sensitive habitat areas for endangered and threatened species and other biologically unique and sensitive areas are excluded, an estimated 85 percent of the total currently identified potential geothermal land in the western United States can be utilized with minimal adverse impact to living resources. However, possible impacts from development of the Gulf of Mexico geo-pressured area, another potentially large source of geothermal energy, are less well defined.

The adverse effects of geothermal development are primarily local and include potential air and water contamination, noise, and the presence of steam pipelines and other surface obstructions which can be barriers to animal migration. In most instances the exploitation of geothermal energy can be made compatible with the management of fish and wildlife, and in some situations there are possibilities to enhance fish and wildlife resources if biological input is involved early in the field development process.

In the United States, most of the 3.2 million acres classified by the Geological Survey as Known Geothermal Resource Areas are in the West. Sixty percent are Federal lands, and half of this acreage is in California. The objective of the Federal geothermal energy program is to develop 10,000 to 15,000 megawatts of electric and thermal power by 1985. To stimulate this development, it is estimated that 3 million acres of land must be leased. Fish and Wildlife Service personnel have already provided ecological

recommendations concerning leases involving 828 parcels of public land in eight States for a total of 1,407,185 acres. The Service is continuing its active role by working to identify impacts on fish and wildlife associated with geothermal exploration and development, and making recommendations on how they can be minimized.

The Fish and Wildlife Service cooperates with the Bureau of Land Management in reviewing Federal geothermal lease applications in the 13 western States. Service operations are oriented to include considerations of endangered and threatened species and related critical habitat zones.

A discussion of some of the Project's current and ongoing activities follows.

Oil Shale Activities

Oil shale continues to be an energy source under consideration for potential development. A mature oil shale industry could affect the environment in many ways, including the generation of millions of tons of waste shale. The Fish and Wildlife Service is evaluating the environmental impact to fish and wildlife resources of the present prototype operation, and is outlining mitigation strategies for potential development alternatives.

Part of the Department of the Interior's prototype oil shale leasing program involves developing methods and technology for the protection of the environment. To accomplish these environmental objectives, detailed environmental stipulations are included as a part of each lease which require and are based on environmental baseline data pertaining to the quantity and quality of both surface and ground water, the quality of the air, and the status and relationships of flora and fauna. The Fish and Wildlife Service is playing an active role in assessing the biological baseline studies. Some specific activities follow.

- The Fish and Wildlife Service is a member of the Department's Oil Shale Environmental Advisory Panel and is part of the interdisciplinary team serving as staff to the Geological Survey Area Oil Shale Supervisor. The Service has assigned a terrestrial ecologist to support the Area Oil Shale Supervisor, and considerable technical backup assistance through the Western Energy and Land Use Team. An in-depth technical evaluation was com-

pleted of the Detailed Development Plan and environmental baseline program submitted for each oil shale lease tract. The analysis provided detailed recommendations on improving the design for measuring environmental impacts and recommendations on designing the required monitoring program. The supplemental

irrigated status due to oil shale development and developing alternative mitigation goals for losses expected to be incurred from development. Each of the studies has applicability to conventional mining or in-situ extraction situations. Because of the heavy metals and toxic organics associated with oil shale, a study

ecological impact patterns by monitoring key indicator species. Biological aspects of the model will be completed during 1977.

- Several other research efforts related to impacts of oil shale development on fish and wildlife were undertaken. Oil shale research needs were identified under a environmental impact statement for in-situ development leases is currently being analyzed.
- A computer-supported simulation model based on data from one of the Detailed Development Plans is being developed to serve as an early warning system. The model is designed to recognize adverse contract with the Thorne Ecological Institute and the results published in a report entitled "Wildlife and Oil Shale: A Problem Analysis and Research Program." Other projects are examining the effects of the reversion of irrigated lands to non-

was initiated to evaluate the occurrence and effects of trace elements in food chains in the Piceance Creek Basin of Colorado. The study is jointly funded with the Energy Research and Development Administration.

Continued participation is planned in preparation of the in-situ oil shale supplemental environmental impact statement, and in the Department's other oil shale activities. Research studies currently underway will be completed. The oil shale model will be tested on other mineral situations in the future.

- As described, the Fish and Wildlife Service is an active participant in the Department's accelerated leasing program to help assure adequate protection of fish and wildlife. The Service formalized a cooperative Memorandum of Understanding within the Department of the Interior with the Geological Survey and the Bureau of

Land Management which establishes procedures for Fish and Wildlife Service input into the Department's accelerated leasing program for geothermal lands.

- The Service participates on the Interagency Geothermal Environmental Advisory Panel which was established by Secretarial Order and consists of senior representatives of each agency to provide on-site advice and assistance on environmental matters to the Area Geothermal Supervisor and the Secretary of the Interior.
- State and Federal biologists have been trained to deal effectively with environmental problems associated with geothermal activities. Three workshops for Federal and State biologists dealing with geothermal activities in the United States were conducted. In addition to many scientists in the Service, 170 biologists from 15 States and other Federal agencies have been trained. In addition, a report entitled the "Geothermal Handbook" defining the nature and extent of biological impacts associated with geothermal resources was completed and distributed. Although designed primarily for guidance and use by State and Federal wildlife biologists working on Federal lands, it has been widely used by the geothermal community. The Energy Research and Development Administration has cooperatively reprinted the handbook for wider distribution and use.
- The Fish and Wildlife Service has participated in various baseline and monitoring studies necessary to assess the environmental effects of geothermal development. The Service assisted in the design of an Environmental Baseline and Monitoring System for biological resources to help the Geological Survey formulate monitoring requirements. The Service also assisted in the study design of the Imperial Valley Environmental Baseline and Monitoring Program sponsored by the Energy Research and Development Administration in cooperation with Lawrence Livermore Laboratory. Efforts continued on the development of aquatic and terrestrial baseline data for the Geysers geothermal area of California. This cooperative effort involved the Pacific Gas and Electric

Company, Union Oil Company, California Department of Fish and Game, and the Service.

- To better assess the impact of geothermal development, two broad studies were initiated. The first was a study to develop techniques for predicting probable effects of commercial-scale geothermal development on fish and wildlife resources in the western United States. The resulting methods and techniques will be published in a manual, scheduled to be released by the end of 1977. The second study, to identify the ecological implications of development of geothermal energy from the Gulf Coast Geopressurized Zone, was recently started. The final report, designed to identify the impacts and describe possible alternatives and mitigation options, is scheduled to be published in June 1977.

The Geothermal Project will continue activities initiated in FY 1976. Based on availability of funds and manpower, field operations will be directed to priority areas identified by the Department of the Interior.

Other Mineral Activities

With growing world demand for minerals of all kinds, efforts to expand U.S. production of many minerals are increasing. Frequently, new non-energy mineral developments will be in deposits of low concentration, because the rich finds near the surface have been depleted. Thus, it will be necessary to dig deeper or extend mining operations over much larger areas than before and at higher economic and environmental costs, and it is inevitable that fish and wildlife resources may suffer.

Information on the fish and wildlife impacts from various mineral extraction processes (including transport, beneficiation, water demands, and secondary effects) is largely limited to the immediate impact of conventional extraction methods. The body of knowledge is limited in the terms of the effects of subtle disruptions to food chains, vegetation cover, microclimate, chemical environment, and reproductive processes. Little is known about the effects of newly emerging extraction technology on fish and wildlife, e.g., extraction methods utilizing acids and other solvents for in-situ leaching, slurry, and hydraulic removal of minerals.

The consequences of the Nation's accelerating mineral demands are that lower grade ores will be extracted, new technology will become economically feasible, and the loss of wildlife and their habitat from related land uses will continue, representing a potential for serious depletion of wildlife resources and the demise of species already in trouble. For example, the current and planned mining of phosphate—one of a long list of critical minerals—is known to have potential for impacting eight endangered species.

Thus, the Fish and Wildlife Service expects to apply the methods and approaches currently being used to deal with coal, geothermal, and oil shale problems to other aspects of terrestrial mineral development. The other mineral activity currently receiving major attention under this project is phosphate mining. The tasks include consideration of phosphate mining in the Los Padres National Forest in California, the accelerated development of Idaho phosphate deposits, and the impact of Florida phosphate mining on endangered species and other wildlife resources.

Other mineral issues will be addressed in the future in accordance with need and availability of resources.

Some of the Project's activities designed to meet these goals are discussed below.

- A large expansion of phosphate development is anticipated in the United States. Because of the many complex issues associated with U.S. phosphate mineral expansion, a system analysis modeling effort has been initiated to identify development scenarios which, while satisfying the Nation's demand for phosphate, could minimize the adverse impacts on fish and wildlife resources. The model will draw the biological baseline data directly into the decision-making process. When completed, the model will serve the Service along with other involved agencies and industry as a guide toward achieving reduced impacts on fish and wildlife. This systems analysis effort is considered to be a prototype one that may be directed in the future to mining problems areas such as copper, aluminum, potash, uranium, and others.
- Technical assistance is being provided in development of a joint Department of the Interior, Council on Environmental Quality, and Environmental Protection Agency

study plan for additional impact analyses related to the central Florida phosphate environmental impact statement effort. This study will rely heavily on results from a Fish and Wildlife Service investigation in central Florida. The study will develop a comprehensive inventory of the fish and wildlife resources for a seven county area in Florida that will serve as a basis for assessment of the effects of mining and reclamation activities of the region. The inventory will be based primarily on available data sources, although provisions are made for limited field work as may be needed to verify the status of particular critical habitat types for species in the study area. Evaluations of the potential effects of phosphate mining on the fish and wildlife resources of the area will be delineated and included in the overall environmental impact statement.

- The Service is coordinating a study of endangered species in the Osceola National Forest of Florida, an area proposed for mining activities. This study, along with the Geological Survey's water resources investigation, will provide supplemental information to the completed environmental impact statement on the area. In addition, this biological data will be incorporated into the phosphate sequencing analysis model.
- The environmental implications of using solution mining techniques for uranium are being studied in cooperation with the State of Montana. Various energy companies are planning to test the feasibility of solution mining for uranium on the Long Pines area of eastern Montana. The study will monitor ecosystem effects of solution mining on the environment. It is essential that the impacts on fish and wildlife associated with solution mining be assessed by the Fish and Wildlife Service because it is likely that solution mining will be applied to other minerals in a number of areas of the country.

Future program efforts will be directed to other known mining issues having most potential for considerable environmental impact. These include: copper, alumina ores, potash, molybdenum, bentonite, copper-nickel-iron ores, sand-gravel-stone, uranium, and peat.

Summary of Program Studies

More than 120 studies, research projects, or related activities were launched, completed, or continued in FY 1976 by the Biological Services Program. For completeness, included are activities during the FY 1976-77 transition quarter and those early FY 1977 activities already underway when this report went to press. Many of the studies fall into the category of applied research. Some are synthesizing existing materials and are designed to produce manuals and guidelines dealing with ecological problems within a relatively short time. Others are designed to develop new information and are longer range in nature; in these efforts, interim reports will be published and distributed as results become available. The various study descriptions are grouped according to Project categories, and listed according to whether they are completed, continuing, or new. Published reports are referenced in Appendix B.

COAL PROJECT STUDIES

The overall objective of the Coal Project studies is to provide new knowledge and methods to minimize the adverse effects of coal development on fish and wildlife resources, with initial emphasis on the western States. The studies cover applied modeling research, development of rapid assessment methods, classification systems, strategies for reclamation and rehabilitation of wildlife habitats, and development of remote-sensing skills. Each study is oriented toward applications and development of a standard methodology.

Completed Studies

Study Title: Assist Federal Wildlife Management Personnel to Develop Expertise in the Use of Remote-Sensing Techniques

Organization: University of Kansas, Center for Research, Inc., Lawrence, Kansas

Investigator: William G. Barr

Biological Services Project Officer: Herbert Quinn

Date: 1/76 - 6/76

Remote sensing, including aerial infrared photography, was employed in coal and oil shale regions to assess environmental impacts. This contract gave the Fish and Wildlife Service's Region 6 management personnel 6 weeks of field experience to learn the application of remote-sensing techniques and interpret data. The contractor had worked with the National Aeronautics and Space Administration in applying remote sensing to wildlife management in Kansas.

Study Title: Ground Truth Information for Color Infrared Photography in Montana and North Dakota

Organization: U.S. Fish and Wildlife Service, Region 6, Denver, Colorado

Investigators: James Gritman
Burton Rounds

Biological Services Project Officer: Jerry Stroeble

Date: 6/75 - 6/76

The Fish and Wildlife Service and the Bureau of Land Management contracted for color infrared photography at a scale of 1:80,000 for large portions of eastern Montana and western North Dakota. This effort developed a design for ground truth information on vegetation and land use. Vegetation was described and delineated in terms of dominant species.

Study Title: Color Infrared Imagery of Eastern Montana and Southwestern North Dakota

Organization: Mark Hurd, Inc., Minneapolis, Minnesota

Investigators: Burton Rounds
James Gritman

Biological Services Project Officer: Jerry Stroeble
Date: 6/75 - 6/76

Color infrared photography was obtained at a scale of 1:80,000 for large portions of western North Dakota and eastern Montana and at a scale of 1:20,000 for smaller selected areas. Imagery was used as base information to determine vegetative communities and land use. This information will be used to characterize wildlife habitats, to assess the impacts of coal extraction and processing, and to evaluate alternative routes for proposed energy-related canals and aqueducts. The Bureau of Land Management contributed to this study.

Study Title: Tree Planting Handbook for the Dakotas
Organization: Lincoln-Oakes Nurseries and North Dakota Soil Conservation Districts, Bismarck, North Dakota

Investigators: Lee Hinds

Biological Services Project Officer: Robert Stewart

Date: 1/76 - 6/76

Several agencies cooperated in the development of a practical handbook to guide the reclamation of mined land and the foresting of other lands. The handbook, titled "Tree Planting Handbook for the Dakotas," details planting techniques and woodland management practices. Cooperating agencies included the North Dakota Association of Soil Conservation Districts, the Agricultural Research Service, the Soil Conservation Service and Extension Services of North and South Dakota, the Fish and Wildlife Service, the North Dakota Game and Fish Department, the Prairie Farm Rehabilitation Authority of Canada, the Alberta Department of Agriculture, and the Northern Forest Research Centre of Canada.

Continuing Studies

Study Title: Effects of Coal Extraction and Related Development on Wildlife Density

Organization: U.S. Fish and Wildlife Service, Denver Wildlife Research Center, Denver, Colorado

Investigator: Robert Phillips

Biological Services Project Officer: Kenneth Burnham

Date: 4/75 - 1/77

The study will characterize selected wildlife habitats and determine the long-term effects of coal development on these habitats and related wildlife population responses. Ultimately, the study results should enable the Service to make recommendations on how mining plans could be altered to have the least detrimental effect on wildlife. The Environmental Protection Agency is contributing to this study.

Basic population indices of selected wildlife species will be established before mining activities and following changes during and after the development period. Principal species under study are deer, antelope, raptors, sharp-tail grouse, and small mam-

mals. The study is also designed to determine the effectiveness of land-reclamation procedures, measure and evaluate the significant habitat types on and near the study areas, and determine how movement patterns of selected wildlife species are affected by mining and related activities. A habitat map of the entire study area should be completed by the end of FY 1977. Numerous quantitative reports will be produced showing how coal extraction and related development affects wildlife.

Study Title: Breeding-Bird Survey, Montana
Organization: U.S. Fish and Wildlife Service, Wisconsin Cooperative Wildlife Research Unit, University of Wisconsin, Madison
Investigator: Joseph Hickey
Biological Services Project Officer: Kenneth Burnham
Date: 5/75 - 5/78

Nongame breeding bird densities will be correlated with major habitat types, including reclaimed spoil lands, and an evaluation will be made of appropriate techniques for breeding-bird surveys. Standardized avian census techniques will be developed for grassland ecosystems. A final report on the densities of breeding birds, an analysis of different census methods, and a recommendation for census methodology modification will be produced.

Study Title: Ecological Energetics and Relationships in a Mixed-Grass Ecosystem
Organization: U.S. Fish and Wildlife Service, South Dakota Wildlife Research Unit, South Dakota State University, Brookings
Investigator: Frank Schitoskey
Biological Services Project Officer: Robert Streeter
Date: 5/75 - 5/78

The study will use an ecosystem approach to determine those populations of terrestrial vertebrate species that appear to be most sensitive to projected changes in the environment and test a related energy-flow model as a predictive technique.

Seasonal vegetation composition and net production will be determined, a list of terrestrial vertebrates on study areas will be developed, and abundance of permanent and seasonal residents will be determined. Detailed ecological studies will be conducted on populations of species that appear to be most sensitive to projected changes in environment. Energy relationships will be simulated.

Products will include:

- Basic inventory data on vegetation and animal populations in the prairies in northwest South Dakota and northeast Wyoming.
- A final report on ferruginous hawk ecology and porcupine ecology.
- A report on habitat selection of representative animals in northern prairie ecosystems.
- Results from a model simulating the energy

dynamics of the primary production through the primary consumers in northern prairies and the relationships to potential impacts of fossil fuel development.

Study Title: Ecological Interactions in Arid Lands
Organization: World Wildlife Fund, Washington, D.C.
Investigators: Clyde Jones
Norman Scott
Biological Services Project Officer: Robert Streeter
Date: 5/75 - 5/78

The study, coordinated through the National Fish and Wildlife Laboratory Field Station at the University of New Mexico, will determine the functional relationships between seed production and seed predators, and the resultant effects on vegetational succession, with special reference to revegetation strategies. The study scope includes plant and animal inventories. The study will determine and assess the impact of disturbance to one animal population on other animal populations and the relationships to the desert flora, and will develop and test samplings and census techniques which are most appropriate to arid land systems. Field perturbation studies and laboratory choice trials will be conducted to determine the functional aspects of the ecological relationships between annual seed production and the primary and secondary consumers.

Products will include:

- Quantitative baseline descriptions of important biotic components.
- Specific management suggestions with respect to key plant and animal species.
- A manual of investigative procedures for field personnel. The manual will include sections in planning a study and analyzing data.
- Scientific evaluations of the primary plant-animal relationships in arid ecosystems.

Study Title: Technical Support to Upland Ecosystems Program—Coal Project
Organization: The Aerospace Corporation, Los Angeles, California
Investigator: Paul Stevens
Biological Services Project Officer: Robert Stewart
Date: 6/75 - 6/77

The Coal Project is developing a 5-year program to assess the effect of coal extraction and processing on fish and wildlife and related ecological values. As part of this program, the contractor will provide technical assistance in the following areas:

- Development of an overview of Federal and State legislation, policies, and activities related to coal extraction and processing.
- Identification of principal extraction and processing technologies and identify anticipated ecological problems associated with each.

- Development of program goals, objectives, tasks, and priorities by geographic areas and levels of effort.
- Integration of the Coal Project with the Oil Shale and Western Water Allocation Projects of the Western Energy and Land Use Team.
- Development of detailed schedules coordinating the pursuit of goals with priorities and milestones.

The work will produce a charter, goals, and program summary for the Coal Project, including multi-year program objectives and priorities.

Study Title: Questions, Rules, and Data—ECOSYM Phase II: Demonstration and Validation

Organization: Utah State University, Logan

Investigator: Larry Davis

Biological Services Project Officer: Robert Streeter

Date: 6/75 - 6/77

This project is continuing the development of ECOSYM, a system for classifying, interpreting, and utilizing ecosystem information for land management planning and decision making. The project is cosponsored with the Forest Service as part of their Surface Environment and Mining Program. The purpose of the work is to test and validate the system, which integrates wildlife values with a hierarchical system of geologic, soil, aquatic, vegetative, and climatic information. Part of the system will be a question analysis process for identifying the informational needs of decision makers. The system can be used by field biologists and also for computerized analyses of coal extraction impacts, mitigation, and opportunities for enhancing the wildlife habitats.

During the testing phase, ECOSYM will be used to map demonstration areas. Two or three animal species will be selected to develop operational rules for identifying the amount, location, and quality of potential habitat, employing information provided by ECOSYM. The association between mapped habitat derived from the "rules" and the actual occurrence of the species will be validated to the extent possible.

New Studies

Study Title: Reclamation Needs of Abandoned Eastern Surface Mines

Organization: Virginia Polytechnic Institute and State University, Blacksburg

Investigator: Burd S. McGinnis

Biological Services Project Officer: Robert Stewart

Date: 4/76 - 4/77

The reclamation of abandoned strip mines in eastern States has been a pending issue for several years. Information is needed on alternatives to restore wildlife resources when reclamation projects are undertaken.

Strip mines that have been abandoned up to 30 years will be studied in eastern Kentucky, Tennessee,

southern West Virginia, and southwestern Virginia. Natural vegetation has recovered at these sites to varying degrees, but some sites are still barren and are polluted with acid and silt.

Descriptions of the topography, vegetation, and terrestrial and aquatic fauna from a small sample of mines will be made initially to determine which measurements are appropriate to evaluate the whole region. When the techniques are developed, simulation models will be created to aid decision makers in weighing alternative reclamation strategies in the affected States.

Study Title: Northern Great Plains Breeding-Bird Survey

Organization: U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, Jamestown, North Dakota

Investigator: Hal Kantrud

Biological Services Project Officer: Robert Streeter

Date: 5/76 - 2/77

The project was an ongoing preliminary effort to (1) develop a satisfactory, realistic classification of grassland biotic communities on the northern interior plains of North America (including the prairie regions of Alberta, Saskatchewan, Manitoba, Montana, and North Dakota, and portions of Wyoming, South Dakota, and Minnesota), and (2) to assess the use of each prairie grassland community type by breeding-bird populations.

The study will be modified during FY 1977 to jointly develop a classification system with the Habitat Assessment Group. In addition, the study will design, plan, and initiate cooperative studies with other Fish and Wildlife Service research elements to quantify the distribution, abundance, and rates of changes of natural and altered ecosystems in the Northern Great Plains. The ecosystems will be characterized as to productivity and importance to the maintenance of avian populations. Finally, models will be developed to predict the impact of habitat changes on the diversity and production of avian populations in the Northern Great Plains.

The final report will include the location of tracts of native prairie of 40 acres or more, a preliminary prairie classification system, and the value of each community type to breeding-bird populations.

Study Title: Existing Test Area Imagery

Organization: Photo Science, Inc., Gaithersburg, Maryland

Investigator: James Penrod

Biological Services Project Officer: Denny Parker

Date: 5/76 - 4/77

Existing remote-sensing imagery covering five Regional Environmental Test Areas will be located, identified, indexed, duplicated, and maintained for Fish and Wildlife Service use. The project will utilize the products of the existing work as a basis for

identifying and cataloging the imagery that exists for the western United States and thus identify the suborbital coverage that is lacking in the test areas. The cataloging will consist of a tabular index of all imagery (from 1:130,000 to 1:3,000) including a description of the imagery, its location, availability, and contact points. This study is being supported by Environmental Protection Agency interagency energy research and development funds.

Study Title: Crucial Decision Processes Affecting Energy Resource Development

Organizations: Institute of Public Administration, Washington, D.C., and National Wildlife Federation, Washington, D.C.

Investigator: Frank Graves

Biological Services Project Officer: Harvey Doerksen
Date: 6/76 - 1/77

The purpose of this project is to identify and describe decision processes for the leasing, regulation, and distribution of energy development; the allocation of water for energy; and informational needs related to fish and wildlife resources. A final report will document these decision processes and the related information needs. Each decision process will be illustrated by a flow chart. The report will also include recommendations for more effective Service participation in energy decision making.

Study Title: Bibliography of Published and Unpublished Information

Organizations: Commissioner, North Dakota Fish & Game Department, Bismarck
Director, New Mexico Department of Game & Fish, Santa Fe
Utah State Department of Natural Resources, Division of Wildlife Resources, Salt Lake City
Ecology Consultants, Inc., Fort Collins, Colorado

Investigators: William Lynott - North Dakota
John Wood - New Mexico
Jeffrey Low - Utah
Timothy Joseph - Ecology Consultants, Inc.

Biological Services Project Officer: Robert Raleigh

Date: 6/76 - 7/77—North Dakota

7/76 - 6/77—New Mexico

7/76 - 7/77—Utah

3/76 - 7/77—Colorado

10/76 - 6/77—Montana-Wyoming

An annotated and indexed bibliography of published and unpublished technical information will be compiled on the flora, fauna, and physical characteristics of each of the five Regional Environmental Test Areas of the Western Energy and Land Use Team. The final product will consist of five separate, annotated, and indexed bibliographies along with computer tapes for each bibliography; one for each of the five test areas.

Study Title: Closed Population Density Estimation (Capture/Recapture) Techniques

Organization: U.S. Fish and Wildlife Service, Utah Cooperative Wildlife Research Unit, Utah State University, Logan

Investigator: David R. Anderson

Biological Services Project Officer: Kenneth Burnham
Date: 6/76 - 6/77

This project will produce a user's handbook on comprehensive, up-to-date methods for statistical analysis of capture data from closed (except for known removals) animal populations. Both live trapping and removal methods will be dealt with. The program of density estimation (animals per unit area) will be dealt with as well as the more common addressed problem of estimation of numbers at risk of capture. Also, computer programs will be written implementing all useful analyses. The handbook will be a guide to these programs.

Little new research is called for; the project will make available new analysis methods developed within the past 4 years, but not yet published. These methods are especially oriented to small mammal live trapping data and electrofishing removal data. This study is being supported by Environmental Protection Agency interagency energy research and development funds.

Study Title: Plant Information Network

Organization: Colorado State University, Office of Sponsored Research, Fort Collins

Investigators: Robert Adams

Dieter Wilkin

Phillip Sims

Biological Services Project Officer: Phillip Dittberner

Date: 6/76 - 6/77

An information system to catalog taxonomic, geographical, ecological, biological, and economic information on plant species will be modified and tested on the Colorado and Montana-Wyoming Test Areas. The result will be an operational system to aid in the selection of vegetative species that can grow under specified site and land-use conditions and serve as a planning tool to identify geographical distributions of plant species, their habitat, and major attributes.

Handbooks for the Northern Colorado Test Area and Southwest Montana/Northeast Wyoming Test Area will discuss plant species and their attributes and characteristics important to successful reclamation of disturbed areas. A technical user's guide will describe the use of the Rapid Access Plant Information Retrieval software package and the Plant Information Network data bank.

Study Title: Reclamation Potential of Energy Disturbed Lands

Organization: Intermountain Forest and Range Experiment Station, U.S. Forest Service, Logan, Utah

Investigator: Paul Packer
Biological Services Project Officer: Phillip Dittberner
Date: 6/76 - 6/77

This project will develop and implement a standard qualitative evaluation of the rehabilitation potential of all major, strippable coal areas. The study will include an inventory and survey of reclaimed areas in Montana, Utah, Wyoming, Colorado, New Mexico, and Arizona. A more detailed quantitative approach will also be investigated to determine the site and environmental variables important in evaluating rehabilitation potential of western coal areas and test the analytical, interpretive, and predictive capability of conceptual word and regression models.

Products will include:

- Maps delineating and describing rehabilitation response units in those areas of surface-mineable coal in the interior West, exclusive of the Northern Great Plains.
- Reclamation fact sheets for each major coal surface mine in the West. These will include site descriptions, overburden movement and shaping, land leveling, seedbed preparation, and other reclamation techniques used.
- A report on the relationships of key variables that influence reclamation success and are also useful for predicting reclamation potentials.

Study Title: Acquiring Test Area Imagery
Organization: HARP, Ltd., Denver, Colorado
Investigator: Robert Heckendorf
Biological Services Project Officer: Denny Parker
Date: 6/76 - 8/77

This project is designed to acquire imagery at a selected scale for the Regional Environmental Test Areas by duplicating the existing best one-time copy Test Area imagery currently located at various other agency offices, obtain new aerial photography where coverage for each Test Area does not exist, and purchase digital magnetic tapes of specific LANDSAT Imagery for each Test Area. The acquisition of imagery will be a joint effort among the Fish and Wildlife Service, Bureau of Land Management, and Environmental Protection Agency, and will be coordinated by Biological Services Program personnel in Region 6.

Study Title: Line Transect Techniques
Organization: U.S. Fish and Wildlife Service, Utah Cooperative Wildlife Research Unit, Utah State University, Logan
Investigator: David R. Anderson
Biological Services Project Officer: Kenneth Burnham
Date: 6/76 - 11/78

The project objectives are: (1) clarify proper field procedures for conducting line transects; (2) develop valid, statistical inference methods for obtaining density estimates from line-transect data; (3) develop

a computer program implementing the results of objective 2; and (4) produce an applied handbook on practical use of line transects in inventory and assessment work. The approach to objective 2 will be a combination of theoretical statistical research computer simulation, and empirical testing on real field data where the true density is known. The principal application is to estimate wildlife population densities (e.g., deer, grouse, and nongame birds).

A report titled "Guidelines for Line Transect Sampling of Biological Populations" has already been prepared. In addition, computer programs for analyzing line transect data and a comprehensive handbook on line transect methodologies and data analyses will be produced. Funds for this study are being provided by the Environmental Protection Agency under their Interagency Energy Research and Development Program.

Study Title: Reclamation Assessment: State-of-the-Art

Organization: Utah State University, Logan
Investigator: Cyrus M. McKell
Biological Services Project Officer: Phillip Dittberner
Date: 7/76 - 4/77

This study is designed to review literature and past and present research, make recommendations, and provide the necessary guidelines and information to managers making revegetation, rehabilitation, and reclamation decisions concerning disturbed wildlands and altered wildlife habitats.

Study results will include a state-of-the-art review and an annotated bibliography for the reclamation of western wildlife habitat, along with a review of current research projects related to reclamation of western wildlife habitats.

Study Title: Inventory of Mined Lands
Organization: NALCO Environmental Sciences, North Brook, Illinois

Investigator: Kent Evans
Biological Services Project Officer: John Morrison
Date: 7/76 - 7/77

All available sources of information (e.g., Government records, mining company records, and other published sources) will be examined to identify and describe surface-mined land areas greater than 10 acres in the western States and North and South Dakota (13 subject States). Only coal, phosphate, and uranium mines will be included in this search.

An atlas of land surfaces mined between 1900 and 1976 will present maps, by State, of the disturbed sites, together with the narrative and tabular data. The atlas will be cross indexed to include orphaned lands, reclaimed lands, acreage-size classes, vegetation types, mining operators, mining methods, products extracted, and other appropriate subjects. Maps will be produced on mylar overlays large enough (approx.

1:1,000,000) to enable accurate location of the strip-mining area with the aid of other information contained in the atlas.

Study Title: Testing a Simulation Approach to Predicting Reclamation Success

Organization: Natural Resource Ecology Laboratory, Fort Collins, Colorado

Investigators: James E. Ellis
William J. Parton

Biological Services Project Officer: Kenneth Burnham
Date: 8/76 - 8/77

This study will test the effectiveness of ecosystem modeling in projecting the success of various coal mine reclamation efforts. The effort will determine how rehabilitation for wildlife is affected by variations in ecosystem conditions remaining after strip mining and by alternative reclamation strategies.

A simulation model will be developed to replicate the response of the perturbed ecosystem to alternative rehabilitation strategies over a 10-year period. The study will include an extensive compilation of pertinent literature on strip-mining impact, a series of local effects models to simulate alternative strategies for coal surface mining reclamation, and modification and redevelopment of the existing ecosystem simulation model to make it applicable to the current problem. Outside experts will scrutinize the models by sensitivity analysis and by comparison of model prediction to real field data.

Study Title: Habitat Classifications Systems

Organization: Ecology Consultants, Inc., Fort Collins, Colorado

Investigator: Stephen G. Martin

Biological Services Project Officer: Harry Coulombe
Date: 9/76 - 3/77

The purpose of the study is to compile a list and associated description of all land use and vegetation classification systems in use by Federal and State land and resource management and planning agencies in the western United States and evaluate each system. Support for this study is being provided by the Environmental Protection Agency with interagency energy research and development funds.

The project will encompass the States of North Dakota, South Dakota, Nebraska, Kansas, Texas, New Mexico, Colorado, Wyoming, Montana, Idaho, Utah, Nevada, Arizona, California, Oregon, Washington, and Alaska. It will include all State agencies, and State and regional offices of Federal agencies involved in renewable resource management, planning, and research. Although much of the survey work can be conducted by telephone, personal visits will also be performed whenever necessary.

A final report will outline all classification systems used by western management agencies and evaluate each system in terms of its purpose, its capability for

more general application, advantages and disadvantages, and the degree to which it meets its objective.

Study Title: LANDSAT Digital Data Classification

Organization: Bendix Aerospace Division, Ann Arbor, Michigan

Investigator: Robert Rogers

Biological Services Project Officer: Denny Parker
Date: 9/76 - 6/77

The study will obtain and process LANDSAT digital data by computer to produce vegetation and land use surface feature classifications according to a classification system to be supplied by the Fish and Wildlife Service on the five Regional Environmental Test Areas, and produce color-coded thematic classification maps in a positive transparent film format of the areas classified. Error analysis and quantitative evaluation will be conducted on classification accuracy, geographic accuracy, and a real measurement precision on all areas classified.

A manual will be developed to explain the methods, applicability, advantages, disadvantages, and limitations of LANDSAT digital data relative to fish and wildlife habitat evaluations. In addition, computer written, color-coded maps for all the land area within each Regional Environmental Test Area will be produced at a scale of 1:250,000. This study is being supported by Environmental Protection Agency inter-agency energy research and development funds.

Study Title: Utilization of Coal Mine Waste Water for the Development of a Northern Pike Spawning Marsh and Waterfowl Nesting Area: Field Demonstration

Organization: U.S. Fish and Wildlife Service, Montana Cooperative Fishery Research Unit, Montana State University, Bozeman

Investigator: Richard Gregory

Biological Services Project Officer: Lee Ischinger
Date: 9/76 - 6/77

An aquatic habitat-enhancement technique for the Decker Coal Mine in Montana is being field tested. The technique uses settling (sediment) pond effluent to create a northern pike spawning and waterfowl nesting marsh. Fertilization and hatching experiments will be conducted with northern pike eggs in the mine effluent waters; the existing basin will be modified to provide a controlled spawning marsh with 8 to 10 waterfowl nesting islands; sexually mature northern pike will be planted in the spawning marsh; and development, hatching success, and fry and fingerling survival will be monitored as well as waterfowl production and aquatic mammal use.

A demonstration marsh for northern pike spawning and waterfowl production will be developed. An operationally oriented, step-by-step handbook will be assembled detailing the methods and techniques developed in the study as well as the application and limitations of the results to other coal developments in the Northern Great Plains.

Study Title: Baseline Study Standards

Organization: Ecology Consultants, Inc., Fort Collins, Colorado

Investigator: James States

Biological Services Project Officer: John Morrison

Date: 9/76 - 9/77

This project is to create a clear, practical, and operational definition of ecological baseline studies. In addition it will describe the fundamental rationale, purpose, and appropriate methodology for conducting ecological baseline studies. Products will be a bibliography of references, thesaurus of key terms and technical definitions, and recommended methods and procedures for ecological baseline studies.

Study Title: Habitat Enhancement-Aquatic Systems

Organization: Enviro Control, Rockville, Maryland

Investigator: Wayne Nelson

Biological Services Project Officer: Lee Ischinger

Date: 9/76 - 4/78

The measure and program features of water development projects which were recommended by the Fish and Wildlife Service and were implemented by construction agencies will be surveyed. The recommended measures shall be presented separately for each of the Fish and Wildlife Service Regions 1, 2, and 6, for which Regional Offices are located in Portland, Albuquerque, and Denver, respectively.

The measures that were recommended and those that were implemented will be identified, and a preliminary assessment of problems associated with implementation in those instances where recommendations were not followed.

The projects to be included in this study are dams, diversions, and related facilities that were constructed by a Federal agency, or licensed by the Federal Power Commission. Thirty projects will be selected for study in each of the three Service Regions. A handbook will be produced outlining the habitat improvement features of Federally constructed or sponsored projects that proved the most effective for enhancing wildlife.

Study Title: Evaluation of Color Infrared Imagery Analysis Techniques

Organization: HRB Singer, Inc., State College, Pennsylvania

Investigator: John Sparks

Biological Services Project Officer: Denny Parker

Date: 9/76 - 5/78

The study will evaluate and compare manual and machine-aid analog and digital processing of color infrared (CIR) imagery for extracting detailed ecological and land-use information. Tests will be conducted to determine the capability of medium-scale CIR imagery to delineate the distribution of certain land cover classes. The capability of CIR imagery to provide quantitative estimates of species composition, frequency, and density or vegetation will be investigated. A user oriented report will be prepared

documenting the overall study approach, the accuracy and unit cost of the methods, time requirements for each method, and the advantages and disadvantages of manual and machine aided analog and digital processing of CIR imagery. The Environmental Protection Agency is supporting this study with interagency energy research and development funds.

Study Title: Wildlife Values: A Household Production Function Approach

Organization: University of Wyoming, Laramie

Investigator: Thomas Crocker

Biological Services Project Officer: William King

Date: 10/76 - 4/78

The lack of adequate estimates of the economic value of wildlife places these resources at a disadvantage in certain governmental planning processes. The study will estimate the economic value of wildlife with a recently developed approach, the household production function approach. The basis of this approach is that families use inputs such as wildlife to produce a desired experience such as a hunting trip or a camping trip to a wildlife-rich region.

The final report will detail the method of wildlife valuation producing the most accurate estimate of present wildlife values, estimates of wildlife values, and expenditure data to be used in estimating impacts on regional economics caused by increase or decline in wildlife populations.

Study Title: Wildlife Values: A Bidding-Game Approach

Organization: University of Wyoming, Resource and Environmental Economics Laboratory, Laramie

Investigator: Ralph d'Arge

Biological Services Project Officer: William King

Date: 10/76 - 4/78

The household production function approach used in the previous study produces highly accurate estimates of the value of wildlife in various outdoor recreation activities. However, this approach does not estimate the existence value of wildlife. The project will use a bidding-game survey to accomplish two purposes: (1) estimate the existence value which people place upon the wildlife resource; and (2) provide a check on the value estimates. The bidding-game survey, a complex technique, will determine the amount people are willing to pay for the enjoyment of the wildlife resource.

Study Title: Composite Mapping and Analysis System
Organization: Federation of Rocky Mountain States, Denver, Colorado

Investigators: Douglas L. Mutter

George Nez

Larry Salmen

Biological Services Project Officer: Kenneth Burnham

Date: 11/76 - 11/78

The purpose of this project is to modify and implement, for Fish and Wildlife Service operational use, a computer based system for storing, manipulating, analyzing, and displaying the array of map based information being compiled in other Western Energy and Land Use Team projects. It will allow for the rapid transfer of a common Service data base for use by a multiplicity of users. Results will provide users with computer methods to rapidly assess the impacts of energy and water development projects and to do regional planning using all the available geo-based data. The system will be tested in the Service's Montana-Wyoming Area Office. Training classes and sessions will be conducted for regional personnel. Funds for this study are being provided by the Environmental Protection Agency under their Interagency Energy Research and Development Program.

Study Title: Surface Mining Effects and Stipulations Manuals

Organizations: Ecology Consultants Inc., Fort Collins, Colorado, and Hittman Assoc., Inc., Columbia, Maryland

Investigator: Russell Moore

Biological Services Project Officer: Lee Ischinger

Date: 12/76 - 9/77

The objectives of this project are to summarize surface mining technology and activities and the related physical, chemical, and biological impacts in the western United States. A handbook for each of three western geomorphic regions (Northern Great Plains, Rocky Mountain, and Arid Southwest) will be prepared summarizing surface mining impacts on fish and wildlife, recommended environmental stipulations, and a flow diagram indicating when and where control stipulations can be introduced to benefit fish and wildlife.

POWER PLANT PROJECT STUDIES

Research studies are aimed at reducing the ecological effects inherent in the siting and operation of large steam-electric power plants. The work includes the preparation of materials to assist in the assessment of biological impacts and the development of a comprehensive plan for the Power Plants Project.

Completed Studies

Study Title: "POWER" A Computer System for Corridor Location and Land Use Decisions

Organization: Virginia Polytechnic Institute and State University, Blacksburg

Investigator: Robert Giles

Biological Services Project Officer: Kenneth D. Hoover

Date: 1/76 - 10/76

Clearing and maintenance for electric, gas, highway, coal slurry, and other rights-of-way can have profound effects on wildlife and their habitat. One way

to approach the environmental impact assessment of such corridors is through a systems concept. The "POWER" model is a computer-based technique for locating the optimum corridor from a given data base available for most sections of the country. Initially designed to establish a high voltage transmission line corridor, "POWER" has been generalized for various types of corridors and is applicable to all geographic areas. The "POWER" model documentation and a technical report titled "POWER: A Computer System for Corridor Location," FWS/OBS-76/35, are available.

Continuing Studies

Study Title: Development of Fishes of the Mid-Atlantic Bight

Organization: University of Maryland, College Park

Investigator: Jerry D. Hardy, Jr.

Biological Services Project Officer: John Boreman

Date: 6/75 - 4/77

The objective of this project is to complete a six-volume set of books on the early developmental stages of fishes of the mid-Atlantic Bight. The first volume, which was originally published in 1967 under the title "An Atlas of Fish Eggs and Larvae of the Chesapeake Bay Region" will be updated and expanded. The set will include descriptions of the egg, larval, and juvenile stages of over 300 species, as well as dichotomous keys for differentiating between species. The descriptions will also include the spawning habits of adult fish, their geographic range and distribution, and migrations of the fish at all stages of their life histories.

New Studies

Study Title: Effects of Chlorine on Egg and Larval Finfish

Organization: University of Maryland, Chesapeake Biological Laboratory, Solomons

Investigator: Ronald Block

Biological Services Project Officer: C. Phillip Good-year

Date: 4/76 - 5/77

The study will determine the toxicity of chlorine to eggs and larvae of striped bass, white perch, and blueback herring. A report will present chlorine dose-response functions or other models which will allow computations of percentage mortality as a function of time of exposure and concentration for early developmental stages of these species in the Chesapeake estuarine system.

Study Title: Predicting the Effects on Fish Populations of Power Plant Entrainment and Impingement of Larval Fishes

Organization: Virginia Polytechnic Institute and State University, Blacksburg

Investigator: Allan Tippon

Biological Services Project Officer: C. Phillip Good-year

Date: 6/76 - 6/78

It is often assumed that the operation of density-dependent processes will offset or compensate for the increases in mortality rates in aquatic populations that result from entrainment and impingement at power plants. This project will summarize, analyze, and evaluate existing evidence of compensation in fish populations. It will provide a list of all known forms of density-dependent mechanisms in fish populations and determine how these mechanisms could interact singly and in combination to offset power plant induced stresses on fish populations. Also, scientifically and statistically reliable guidelines will be prepared for measurement of compensation in fish populations.

Study Title: Techniques for Predicting Entrainment and Impingement

Organization: University of Tennessee, Knoxville

Investigator: Arsev Eraslan

Biological Services Project Officer: Mark W. Maher

Date: 7/76 - 6/78

Entrainment and impingement losses are considered to be the most serious impact of power plants on fishery resources; however, these losses cannot be adequately predicted with presently available analytical techniques. The objective of this study is to develop a model for predicting entrainment and impingement losses and to provide a manual for use in analyzing power plant impacts on aquatic organisms. The manual will present the model description, computer code, and techniques for using the model, including discussions on input data requirements, data acquisition procedures, sensitivity of the model, and implications of the model output.

Study Title: Guide to Mathematical Models and Power Plant Impact Assessment

Organization: Battelle Columbus Laboratories, Columbus, Ohio

Investigators: William E. Martin
Sanford Bloom

Biological Services Project Officer: Mark W. Maher

Date: 8/76 - 7/77

The guide will provide basic insight into most mathematical models that have been used in environmental analyses. This document will have nontechnical discussions of the features of biological models, physical models, and atmospheric models. Included in the guide will be discussions of the models and their workings along with such other factors as the relative importance of input parameters, limitations, and misapplications of the models. The document will enable the reviewer of a power plant environmental impact statement to better understand the use of mathematical models for impact analysis, and will assist in providing timely and effective reviews.

Study Title: Factors Associated with Accuracy in Sampling Fish Eggs and Larvae

Organization: Virginia Institute of Marine Science, Gloucester Point

Investigator: John V. Merriner

Biological Services Project Officer: John Boreman

Date: 8/76 - 9/77

This study is an assessment of the accuracy of gear currently employed to sample fish eggs and larvae. The final report will include biological and physical features of aquatic ecosystems that affect attainment of representative samples of fish egg and larvae populations. It will include an assessment of how currently used gear overcomes or succumbs to sampling problems. It will recommend which factors need to be maximized in gear design to allow for the biological and physical features in sampling various ecologic categories of fish eggs and larvae.

Study Title: An Analysis of Power Generation and Transmission Decision Trains

Organization: Asplundh Environmental Services, Ann Arbor, Michigan

Investigator: Michael Galvin

Biological Services Project Officer: John Boreman

Date: 9/76 - 3/78

A summary document will be prepared that analyzes and describes the processes by which environmentally significant electric power decisions are made. Key decision trains for each of the following categories will be included: nuclear power plants greater than 500 MW capacity; coal-fired power plants greater than 500 MW capacity; hydroelectric generating plants, including pumped storage; and electricity transmission lines greater than 230 KV. Descriptions of the decision trains will include representative flow charts, an identification of preliminary and final decision points along a time line, an identification of the decision makers, and detailed analyses of key decisions which affect fish and wildlife resources.

Study Title: Information Support Services

Organization: Oak Ridge National Laboratory, Oak Ridge, Tennessee

Investigator: Helen Pfuderer

Biological Services Project Officer: Beth Fodor

Date: 9/76 - 9/78

The investigator will compile several comprehensive bibliographies of technical information on selected aspects of the environmental impacts of electric power generation and transmission. The Energy Research and Development Administration is contributing to this study. Products of this project will be: camera-ready manuscripts of bibliographies, including indices and abstracts; a copy of each document cited in the bibliographies for the National Power Plant Team; and magnetic tapes of the bibliographies suitable for a computer retrieval system.

Study Title: Management of Transmission Line Rights-of-Way for Fish and Wildlife
Organization: Asplundh Environmental Services, Ann Arbor, Michigan
Investigator: Michael Galvin
Biological Services Project Officer: Kenneth Hoover
Date: 9/76 - 10/78

Electric utilities operate over 300,000 miles of overhead electric transmission lines which require an estimated 4 million acres of land for rights-of-way. For the most part these lands represent potential fish and wildlife habitats that are not being fully utilized. The objective of this project is to prepare a technical assistance manual that integrates fish and wildlife management techniques and special problems in transmission line rights-of-way into comprehensive management strategies for land used as rights-of-way by electric utilities throughout the United States. The Federal Power Commission and the Energy Research and Development Administration are contributing to this study.

Study Title: Strategy for Estimating Impacts of Power Plants on Fish and Shellfish
Organization: E.G.&G., Environmental Consultants, Waltham, Massachusetts
Investigator: Curt Rose
Biological Services Project Officer: C. Phillip Good-year
Date: 12/76 - 12/78

A major difficulty in assessing or predicting environmental impact of existing and proposed power plants is that the available data are often irrelevant or extraneous, and conclusions are not related to the stated hypothesis. This problem will be addressed by development of a manual which will summarize proper assessment strategies. The Environmental Protection Agency is providing partial funding for this study with interagency energy research and development funds.

HABITAT CLASSIFICATION AND ANALYSIS

The Biological Indicators Project is in the early stages of formulating a strategy for determining whether certain organisms can be employed as monitors of trends of environmental quality. The following studies are assisting in the development of the strategy.

Completed Studies

Study Title: A National Inventory of Selected Biological Monitoring Programs
Organization: Oak Ridge National Laboratory, Oak Ridge, Tennessee

Investigators: Robert L. Burgess
Fred G. Goff
Homer T. Kemp
Robert J. Olson

Biological Services Project Officer: Albert Sherk
Date: 6/75 - 9/76

The objective of this study was to identify, systematically describe and catalog, and display selected summary data from present biological monitoring programs. The data base provides extremely diverse and essential information from any ongoing, systematic, periodically conducted samplings, compilations, inventories, or studies for which the type of data and the period of record are, or can be, amenable to meaningful trend analysis.

The study focused on the types of monitoring data that offer the greatest potential for being effectively coordinated, as well as for providing systematic overview presentations of biotic trends. Emphasis was placed on data pertaining to the status of endangered and threatened plant and animal species, important natural areas (including wetlands), population dynamics (including censuses), status, behavior, productivity, management techniques, and uses of our Nation's living natural resources and related ecological system. The study also considered the condition, structure, diversity and perturbations of biotic communities and ecosystems.

In addition to the final report detailing the systems, the NBIC data base (approx. 1,000 records) is on-line and searchable in the interactive mode at Oak Ridge National Laboratory on the ORCHIS System, ORLOOK Program. The MINI-BIOMON data base (approx. 3,000 records), containing all information received in shortened format is searchable on the above system.

Study Title: National Survey of Biological Monitoring Programs Information System: Options Analysis

Organization: Battelle Columbus Laboratory, Columbus, Ohio

Investigator: Gabor J. Kovacs
Biological Services Project Officer: Albert Sherk
Date: 6/75 - 9/76

This study evaluates management options available to the Service for the recently completed Biological Monitoring Data Base. The investigator made a comprehensive evaluation of both the data base and the operating computer retrieval system.

Specific recommendations were made on how to maintain and improve the data base. Results were summarized in the final report. An evaluation of user response to the data base is being conducted.

Continuing Studies

Study Title: Waders and Shorebirds as Indicators of Environmental Quality
Organization: U.S. Fish and Wildlife Service, Patuxent

Wildlife Research Center, Laurel, Maryland

Investigator: Lucille F. Stickel

Biological Services Project Officer: Albert Sherk

Date: 1/75 - 9/77

This study is testing the hypothesis that man-induced changes of estuarine and coastal habitats can be assessed through the use of wading birds as biological indicators. Wading birds have been chosen because they are a terminal link in the aquatic food chain, reveal maximum contaminant levels in a given area, are relatively easy to observe, and are spread throughout the United States. These qualities may allow the development of a monitoring program with wide geographic usage.

The study is focused on major heronries in the estuarine systems along the Atlantic coast. Information is being collected on species composition, population density, and contaminant residue levels in specific habitats. Heron population trends will be compared with water quality, chemical contamination, habitat structure, and human disturbance.

NATIONAL WETLAND INVENTORY PROJECT STUDIES

Research is underway to find the most effective methods of accomplishing a new wetlands inventory in the shortest possible time. One study is concerned with the adaptability of a U.S. Geological Survey system, which could reduce both costs and time. Other studies are indexing the availability of aerial photography and examining State and regional wetland inventories for possible incorporation in the projected national inventory.

Completed Studies

Study Title: Adaptability of the LUDA Program to the National Wetlands Inventory

Organization: University of Massachusetts, Department of Forestry and Wildlife, Amherst

Investigator: Joseph Larson

Biological Services Project Officer: John Montanari

Date: 6/75 - 3/76

The U.S. Geological Survey's Land Use Data and Analysis (LUDA) program was investigated for its applicability to the National Wetland Inventory. The LUDA is mapping the entire Nation on a 1:250,000 scale, and it could be a unique vehicle for assisting the Wetland Inventory Project. The LUDA effort has produced a procedural and mechanical matrix for gathering, storing, retrieving, displaying, and analyzing wetland and associated environmental data on which management decisions can be made.

The study contractor determined the compatibility of the LUDA classification system and a new wetland

classification system being developed by the inventory project offices. The work involved testing the two systems in coastal, grassland, and forest climax areas, and producing up to three sample maps.

An evaluation was made of the possibility of improving wetland delineation through wetland interpreters more specialized than those used by LUDA to determine whether such an investment is warranted. The specific procedures necessary to employ LUDA as the prime base for the new National Wetland Inventory were documented.

Study Title: Index of Selected Aerial Photography

Organization: Photo Science, Inc., Gaithersburg, Maryland

Investigator: Andrew Martin

Biological Services Project Officer: Allan Marmelstein

Date: 5/75 - 5/76

Compilation of a graphical index of existing, high-quality aerial photography was a necessary step to locate the imagery needed to conduct the National Wetland Inventory.

The index prepared in this study (displayed on 1:750,000 scale maps) gives the location and extent of recent aerial photography (since 1970) subject to specific parameters based on the requirements of the Inventory project. These parameters include such restrictions as: scales of 1:24,000 - 1:130,000, exceptionally high-quality photos, and 0% cloud cover.

Study Title: Survey of Wetland Inventories

Organization: MTL Ecological Systems, Baltimore, Maryland

Investigator: Harold Flynn

Biological Services Project Officer: John Montanari

Date: 5/75 - 5/76

Information was compiled on wetland inventories conducted by Federal, State, and local governments, and private conservation groups since 1965. The National Wetland Inventory Group will utilize these inventories, when possible, to avoid duplication of effort.

The study has been issued in seven sections. Six sections, each respectively representing one of the six Fish and Wildlife Service Regions, contain State maps (scale 1:750,000) showing the location and extent of major wetland inventories. The seventh section contains a narrative description, by State, of all known inventories since 1965. This description includes such inventory information as the classification system used, the purpose of the inventory, the methods used, and the legislation involved.

Study Title: Preparation of Ecoregion and Physiographic Maps of the Conterminous United States

Organization: Earth Satellite Corporation, Washington, D.C.

Investigator: David Thibault

Biological Services Project Officer: John Montanari
Date: 6/75 - 6/76

A series of 1:250,000-scale maps were prepared which display Ecoregions, as defined by R. Bailey, U.S. Forest Service (map: 1976) and Physical Subdivisions and Land Surface Form, as defined by E. H. Hammond (maps: 1965, 1969). This series of 468 maps, covering the conterminous 48 States, displays these physical units on standard 1:250,000 U.S. Geological Survey base map sheets.

Study Title: Development and Testing of a Computerized Wetlands Evaluation System

Organization: Beak Consultants, Inc., Portland, Oregon

Investigator: John Dueker

Biological Services Project Officer: Allan Marmelstein
Date: 6/75 - 10/76

Many kinds of data may exist which are useful in determining the value of any given wetland. This project was designed to develop a systematic computer-compatible method for organizing such data in a fashion consistent with the hierarchical structure of the new wetland classification system. By organizing available data in a fashion compatible with the classification system, the task of extracting information of biological value is made simpler. The method developed is capable of accepting large amounts of complex biological data.

Study Title: Technical and Equipment Development of the Wetland Analytical Mapping System

Organization: Photo Science, Inc., Gaithersburg, Maryland

Investigator: Andrew Martin

Biological Services Project Officer: Bill Wilen
Date: 5/76 - 11/76

In this project, the Analytical Photogrammetric Positioning System, which was originally developed for the Department of Defense, was adapted for use by the National Wetland Inventory Group. Inventory procedures were tested and an operations manual developed.

Study Title: Field Testing of Interim Wetland Classification System

Organization: Martel Laboratories, Inc., Baltimore, Maryland

Investigator: Harold Flynn

Biological Services Project Officer: John Montanari
Date: 5/76 - 12/76

This project provided the necessary field testing of the "Interim Classification of Wetlands and Aquatic Habitats of the United States" to assure its ecological validity and usefulness. Twenty-two test sites within the conterminous United States were chosen, by mutual agreement between Fish and Wildlife Service personnel (both research and operational) and the

contractors, that represented major wetland environments in the United States. A report describing test procedures and results was prepared for each test site. An overall report focusing on suggested modifications to the classification system was prepared to improve its utility.

New Studies

Study Title: Preparation of Guidebooks for Wetlands Protection at the State and Local Levels

Organization: Environmental Law Institute, Washington, D.C.

Investigator: Jon Kusler

Biological Services Project Officer: John Montanari
Date: 3/76 - 3/77

Guidebooks for wetlands protection are being prepared for use by State and local units of government and interested citizens. Existing State and local wetland protection efforts are being examined and alternative model statutes and ordinances are being drafted. Two guidebooks are being prepared: one will be a scientific and legal handbook detailing technical planning issues (including wetland inventories), legal issues, and regulatory and non-regulatory approaches to wetlands protection; the other, specifically for local units of government, will present model ordinances and a step-by-step approach for adopting local wetlands regulations.

INFORMATION TRANSFER PROJECT STUDIES

The Information Transfer Project is developing a national fish and wildlife environmental information transfer network. The following studies are contributing to the conceptualization of the network and the establishment of data bases.

Completed Studies

Study Title: Technical Assistance in Planning and Development of Information Transfer Capability for the Biological Services Program

Organization: Battelle Columbus Laboratories, Columbus, Ohio

Investigator: Richard Simon

Biological Services Project Officer: Allan Hirsch
Date: 3/75 - 6/75

The objective of this project was to prepare a plan to pilot test the feasibility and utility of installing computer terminals in the Biological Services Program headquarters and at each of the national team offices. The terminals would enable access to selected information sources. Assistance also was given in long-term planning for the continued development and expansion of a variety of project capabilities. Findings were included in a report giving the pilot plan and long-term planning.

Study Title: Office of Biological Services Scope of Interest and Available Information Sources: An Initial Survey and Analysis
Organization: Ocean Data Systems, Inc., Rockville, Maryland
Investigators: William J. Hart
Klaus G. Liebhold
Biological Services Project Officer: Bernard K. Dennis
Date: 1/76 - 3/76

Based on this study, the information transfer network being developed by the Biological Services Program would require the following major components:

- A system to provide early notice of plans or proposals for major action with potential impact on fish and wildlife.
- A system to keep abreast of recently completed, on-going, and planned applied research relevant to the Biological Services Program's mission.
- Notification of proposed natural resource evaluation and management systems.
- A register of on-going Biological Services projects.
- A method of tracking policy and legislative affairs.

A list of over 1,000 information sources and potential target recipients of Biological Services information, organized by Federal regions, was included in the report.

Study Title: Information Transfer Network
Organization: Mitre Corporation, McLean, Virginia
Investigators: Alfred C. Doermann
John W. Watson
Biological Services Project Officer: Bernard K. Dennis
Date: 1/76 - 10/76

This study was conducted to identify the technical requirements for the information transfer network being developed by the Biological Services Program and to prepare a 5-year development plan. The analysis and design of the plan were based on information obtained from extensive available documentation; interviews with Office of Biological Services and other Fish and Wildlife Service staff in Washington; site visits to Regional, Area and Field Offices and the National Teams; and correspondence and telephone interviews with other Service personnel. Roles of the various network participants were defined and functions, procedures, and equipment required to perform information transfer were identified and described. Options for extending network participation to other Service components and other agencies were considered.

The network approach provides for cooperative sharing of data bases and related information transfer services by all participants.

Study Title: Detailed Design for a Pilot Early Warning System for Fish and Wildlife Information
Organization: Ocean Data Systems, Inc., Rockville, Maryland
Investigators: J. Hugh Nichols
William J. Hart
Klaus G. Liebhold
Biological Services Project Officer: Bernard K. Dennis
Date: 9/76 - 12/76

This study addressed the need for the Fish and Wildlife Service to provide sound ecological information early in land and water resource development planning and decision making. The investigators conducted a requirements study and designed an information system. The objective of the system is to inform appropriate Service personnel about land and water resource development policies, plans and projects. Early and consistent availability of such information is needed to enable the Service to make more timely ecological input to development projects of other agencies and industry.

The design for an early warning system pilot project and an evaluation plan was completed and reviewed by appropriate Service personnel. This pilot project will be implemented as funding becomes available.

New Studies

Study Title: Biological Services Program—Document Distribution System
Organization: Mitre Corporation, McLean, Virginia
Investigators: Alfred Doermann
Mary Jane Ruhl

Biological Services Project Officer: Bernard K. Dennis
Date: 6/76 - 3/77

Development of this system was initiated in FY 1976 to assist with distribution of the FY 1975 Biological Services Program Annual Report. By means of appropriate computer system software and an indexing scheme, the system when completed in FY 1977 will match products produced by the Program with the interests of target users and prepare mailing lists and labels. It will be used by the Program's Information Transfer Specialists as they develop and implement plans for disseminating Biological Services information.

The objective is to be precise in sending information to selected users while making its availability known to others. Because of the large number of potential users of Biological Services information in Federal, State, and local government agencies and the private sector, it is expected that identifying them and keeping the file up to date will be a significant continuing task.

Study Title: Information Transfer Film, "Information Please"
Organization: Argonne National Laboratories, Argonne, Illinois
Investigator: George Lindholm

Biological Services Project Officer: Bernard K. Dennis
Date: 9/76 - 3/77

The film is being funded jointly by the Information Transfer Project and the Water Resources Scientific Information Center (WRSIC). The objective of the film is to describe the need for information in land and water resource development decision making, the respective roles of the Biological Services Program and WRSIC in responding to this need, and to stimulate more effective use of the services and information provided by these two resources.

The resulting 17 minute, color/sound 16-mm. film will be available for loan from WRSIC, the Office of Biological Services in Washington, its four National Teams, and the National Audio-Visual Center.

Study Title: Biological Services Program Bibliographic Data Base Standards

Organization: Mitre Corporation, McLean, Virginia

Investigator: Leo Boberschmidt

Biological Services Project Officer: Leigh Whitlock

Date: 9/76 - 5/77

A costly problem common to most research and development organizations is the lack of use of common information handling standards. This practice is costly because it reduces the availability and accessibility of available information and results in gaps, duplication, and losses.

In this task, appropriate bibliographic standards and input formats were identified and analyzed and recommendations regarding the needs of the Biological Services Program were made.

During FY 1977 a decision will be made on the standards and format to be adopted by the Program Guidelines, and contractual requirements will be prepared and their application initiated. This will assure widespread availability and accessibility of Biological Services information in on-line computerized information services. It will provide a starting point for moving toward the long range objective of a common system of shared data bases and related technical information services to support fish and wildlife related resource management and environmental impact assessment.

Study Title: Development of Plans and Guidelines for Information Dissemination

Organization: Consumer Dynamics, Inc., Rockville, Maryland

Investigators: Diana MacArthur

A. James Miller

Elizabeth M. Uprichard

Arlene N. Snyder

Biological Services Project Officer: Bernard K. Dennis
Date: 9/76 - 9/77

The objectives of the first of this two-phase study were to establish a rationale and strategy for publishing and disseminating information generated by the

Biological Services Program and to provide guidelines for carrying out this strategy.

The study integrates the techniques of information science, communications, and strategic planning as an approach for facilitating the transfer of Biological Services information to target audiences to achieve optimum use. The first phase of the study has resulted in a "Biological Services Program Communications Standards and Procedures" manual. It presents policy standards and procedures for planning, preparing, reproducing, and disseminating printed products.

Work during the second phase of the effort will include:

- Analytic support necessary for developing a plan to examine current operations as related to information and technology transfer.
- Assistance with developing and implementing dissemination plans for high priority Biological Services Program products to involve Program personnel in "learning by doing." The manual will be field tested during this work.
- A chapter of the manual pertaining to dissemination planning and operations will be completed, through examination of operations, training of Program personnel in information transfer, and field testing the manual on priority products.
- Specific recommendations for guidance, performance standards, and operational goals regarding information transfer and centralization of functions.

COASTAL ECOSYSTEMS AND OUTER CONTINENTAL SHELF PROJECT STUDIES

Most of the following studies are intended to develop knowledge and methodologies directly related to minimizing the environmental impacts of future offshore oil and gas development. Other studies are developing information that will assist in improving the environmental aspects of coastal zone resource planning and management.

Completed Studies

Study Title: National Assessment of Estuarine and Near-Shore Marine Resources for the Water Resources Council

Organization: Virginia Institute of Marine Science, Gloucester Point, Virginia

Investigator: Maurice Lynch

Biological Services Project Officer: David Flemer
Date: 1/75 - 8/75

The objective of this study was to assess the effects of selected chemical and physical factors on estuarine and nearshore marine resources and to evaluate

present and future impacts on fish and mammal harvests. The work helps set priorities for fish and wildlife resource problems in relation to various pollution stresses. The study draws upon and updates much of the information published in the National Estuary Study.

Study Title: An Ecological Description of Six California Estuaries

Organization: California Department of Fish and Game, Sacramento

Investigator: John Speth

Biological Services Project Officer: Jay Watson

Date: 6/75 - 8/76

The estuaries under study were Mugu Lagoon, Seal Beach and Huntington Harbor, Santa Maria River, Santa Ynez River, Carpinteria Marsh, and Agua Hedionda Lagoon. This work is part of a State effort to describe all coastal wetlands. The information has been incorporated into the Biological Services Program effort to characterize all of the Nation's coastal ecosystems.

Six reports have been completed and published by the staff of the Coastal Wetlands Program of the California Department of Fish and Game. The reports, part of their Coastal Wetlands Series (CWS), are as follows:

- "The Natural Resources of Carpinteria Marsh: Their Status and Future," CWS Report 13.
- "The Coastal Wetlands of Northern Santa Barbara County," CWS Report 14.
- "The Natural Resources of the Nipomo Dunes and Wetlands," CWS Report 15.
- "The Natural Resources of Agua Hedionda Lagoon," CWS Report 16.
- "The Natural Resources of Mugu Lagoon," CWS Report 17.
- "The Natural Resources of Anaheim Bay," CWS Report 18.

New Studies

Study Title: Endangered Species of Southeastern Coastal United States

Organization: National Fish and Wildlife Laboratory, Washington, D.C.

Investigator: Howard Campbell

Biological Services Project Officer: Donald Woodard

Date: 7/76 - 8/77

This study will include evaluation of endangered species data storage systems of the Fish and Wildlife Service and other agencies, completion of a survey of the endangered and threatened vertebrates of the southeastern United States, identification of management techniques and procedures for protecting endangered species, and preparation of a report with life history and critical habitat information. The final report will be useful to all government planners by providing accurate information about considerations

for endangered species in their area. Such consideration can be an early part of the planning processes, and thereby, reduce project delays.

Study Title: Pelagic Birds of Georges Bank and Adjacent Waters Across the Gulf of Maine: A Pilot Study

Organization: Manomet Bird Observatory, Manomet, Maine

Investigator: Bryan Harrington

Biological Services Project Officer: Ralph Andrews

Date: 8/76 - 9/77

This pilot study is being conducted to provide guidelines for the testing of census techniques and to determine the magnitude of the pelagic bird resource on the Georges Bank area. The investigator is determining species composition, relative abundance, and spatial and temporal distribution patterns of pelagic birds. Preliminary indications are that a large population of birds of several species exists on the Georges Bank about which little is known.

Study Title: Analysis of the Offshore Estuarine and Marine Effects of Coastal and Outer Continental Shelf Oil and Gas Development on Fish and Wildlife Resources and Coastal Ecosystems

Organization: Conservation Foundation, Washington, D.C.

Investigator: John Clark

Biological Services Project Officers: Howard Tait
Larry Shanks

Date: 8/76 - 11/77

The Biological Services Program is coordinating a Fish and Wildlife Service-wide effort to respond to environmental information needs stemming from accelerated offshore oil and gas development. This study will analyze past offshore development experience to help assess future impacts on fish and wildlife on a national basis.

A manual will be prepared describing the full range of potential impacts of Outer Continental Shelf petroleum development. The document will include an analysis of the most significant agencies, their authority and policies, and standards and guidance suitable for Fish and Wildlife Service personnel and others to use in evaluating impacts in the project planning stage. Also included will be discussions of oil and gas technology and activities; the impacts of each activity on coastal resources and ecosystems; analysis of engineering options; and a discussion of alternative courses of action.

Study Title: Assessment of Man's Impact on the Development of Management Methods for Submerged Seagrass Habitats

Organization: University of Alaska, Fairbanks

Investigator: Peter McRoy

Biological Services Project Officer: Paul Fore

Date: 9/76 - 5/77

The objective of this study is to synthesize the relevant information on specific and community seagrass ecology, to evaluate the functional role and monetary value of seagrasses, to assess the impact of perturbations, and to develop a management handbook for preservation and enhancement of seagrasses. To accomplish these objectives, the existing literature and other informational sources will be collated, analyzed, and synthesized for the preparation of the final report which is anticipated to be available the latter part of 1977.

Study Title: Distribution of Nesting Colonies of Birds in the Great Lakes Area

Organization: Northwestern Michigan College, Traverse City

Investigator: William Scharf

Biological Services Project Officer: Larry Shanks

Date: 9/76 - 9/77

This study is cosponsored with the Corps of Engineers Waterways Experiment Station to locate the nesting colonies and significant staging areas for colonially nesting birds in the Great Lakes area. The U.S. Great Lakes shoreline and its islands are being canvassed for breeding colonies and staging areas. Observations, in addition to species composition, include vegetative and substrate sampling, nesting chronology, and a photographic documentation of the colony.

Study Title: Ecological Characterization of the Chenier Plain of Southwest Louisiana and Southeast Texas

Organization: Energy Resources Company, Cambridge, Massachusetts

Investigator: Richard Rosen

Biological Services Project Officer: James Kirkwood

Date: 9/76 - 9/77

This study is being conducted to develop an ecological characterization of the Chenier Plain through the analysis and synthesis of existing literature and information, and to concomitantly develop a conceptual model for the gathering and synthesis of ecological data. The data will provide an overview of the resource and ecological interactions and, thus, will be useful in the assessment of impacts and to planners in the coastal zone. This essential study will result in an atlas and report that will include techniques to conduct an ecological characterization as well as a relevant environmental data base. This study is being supported by Environmental Protection Agency inter-agency energy research and development funds.

Study Title: Biological Impacts of Minor Shoreline Structures on the Coastal Environment: State-of-the-Art Review

Organization: Beak Associates, Inc., Portland, Oregon

Investigator: Ed Mulvihill

Biological Services Project Officer: Larry Shanks

Date: 9/76 - 10/77

Because of concern about the long-term and cumulative effects of shoreline modifications due to the many coastal structures that are being built, this project will synthesize the existing literature and information about the detrimental and beneficial aspects of shoreline structures so that Fish and Wildlife Service personnel may more ably respond to information requests about resource impacts.

Study Title: Liaison and Information Flow With the Dredged Material Research Program

Organizations: U.S. Fish and Wildlife Service and U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi

Investigator: Kenneth Allen

Biological Services Project Officer: Kenneth Allen

Date: 10/76 - 3/77

This project emphasizes the Service's concern with dredging and its impacts on fish and wildlife habitat. The objective is to advise the Corps and to keep Fish and Wildlife personnel informed about the results of the research being conducted by the Dredged Material Research Program at the Waterways Experiment Station. To accomplish this objective, a staff member has been assigned to act in a liaison position and to insure the steady flow of information as results are produced.

Study Title: Survey of Seabirds of Alaska—Outer Continental Shelf Baseline Studies

Organization: U.S. Fish and Wildlife Service, Anchorage, Alaska

Investigator: Calvin Lensink

Biological Services Project Officer: Calvin Lensink

Date: 10/76 - 5/77

This work is being conducted for the National Oceanic and Atmospheric Administration (NOAA), with funding support from the Bureau of Land Management, to conduct the environmental assessment of the OCS waters of Alaska. Fish and Wildlife Service personnel are surveying the seabirds in this area. The primary objectives are to determine spatial and temporal distribution; to catalog location, size, area, species, and composition of each colony; to obtain photographic documentation of each colony; to determine migratory routes, feeding ecology, trophic relationships, and population characteristics; and to conduct a literature review of seabirds in the Alaska OCS. This information is being conducted by aerial and ship censuses along fixed survey lines to determine the spatial and temporal distribution, feeding, and ecology and trophic relationships. This project is ongoing and it is anticipated that work will continue for several more years. Annual reports are being produced and are available from NOAA.

Study Title: Mid-Atlantic Pelagic Bird Survey

Organization: Wildlife Rehabilitation Center, Upton, Massachusetts

Investigator: Phillip Stanton
Biological Services Project Officer: Ralph Andrews
Date: 10/76 - 8/77

Preliminary information will be gathered on the magnitude of the bird resources that occur in the mid-Atlantic area. Observations have already been made from a vessel traveling within a limited area. This technique should provide comparative information about the use of various census techniques for pelagic birds. The field work has been completed and the data are being analyzed. The final report is expected in 1977.

Study Title: Sea and Wading Bird Colony Survey:
Southeast United States

Organization: U.S. Fish and Wildlife Service, Patuxent
Wildlife Research Center, Laurel, Mary-
land

Investigator: Thomas Custer
Biological Services Project Officer: Donald Woodard
Date: 10/76 - 9/77

This study completes the survey of colonies of sea and wading birds along the Atlantic coast. Sea and wading bird colonies were identified in coastal areas of southeastern United States and estimates obtained of numbers in each colony. Field work was completed during 1976 and the final reports will be ready in 1977. Funds for this study are being provided by the Environmental Protection Agency under their Inter-agency Energy Research and Development Program.

Study Title: Sea and Wading Bird Nesting Colony
Survey

Organizations: U.S. Fish and Wildlife Service, Co-
operative Wildlife Research Units of:
Louisiana State University, Baton Rouge
University of Maine, Orono
University of Massachusetts, Amherst

Investigators: John D. Newsom
Howard Mendel
Wendell Dodge

Biological Services Project Officer: Ralph Andrews
Date: 10/76 - 9/77

This survey is being conducted in conjunction with a number of similar studies to identify all the significant coastal nesting colonies of sea and wading birds in eastern United States. The survey scope extends from Maine, southward to the Virginia-North Carolina state line, and the coastal area of Louisiana, Alabama, and Mississippi. Bird colonies will be recorded on maps and in descriptive reports.

The information produced by the study will be an essential element in a program to characterize all the Nation's coastal ecosystems. It also will be applied to the assessment of offshore oil and gas developments, deepwater port projects, and other coastal zone management problems.

Study Title: Synthesis of Information on Submerged
Aquatic Vegetation in Chesapeake Bay
Organization: University of Maryland, College Park
Investigator: Eugene Cronin
Biological Services Project Officer: David Flemer
Date: 10/76 - 9/77

The objective of this study is to synthesize the published and unpublished information about the submerged vegetation in Chesapeake Bay. Emphasis is given to historical trends and distribution, the value of the submerged vegetation for fish and wildlife habitat, and the ecological requirements of the aquatic vegetation. This synthesis is a preliminary study to produce needed information for the planning of future studies in the Chesapeake Bay area. The Environmental Protection Agency is contributing to this study.

Study Title: Assess Ecological and Physiological Ef-
fects of Oil on Birds

Organization: Patuxent Wildlife Research Center,
Laurel, Maryland

Investigator: Lucille Stickel
Biological Services Project Officer: Howard Tait
Date: 10/76 - 10/77

This study will test and adapt analytical methods for the identification of petroleum hydrocarbons and their derivatives in avian tissues. It will evaluate the toxic effects of oil on embryo viability and survival, will assess the prevalence of oil ingestion by wild birds and will relate tissue levels of oil and synergistic effects to survival. Analytical techniques have been verified by cooperating laboratories, and the identification of petroleum hydrocarbons in avian tissues is underway. Preliminary results indicate high mortality of embryos when eggs are subjected to small amounts of hydrocarbons. Considerable work is to be accomplished in this project and most of the results to date are tentative until more thoroughly documented. Various technical reports have been presented at scientific meetings and will be published in symposium proceedings. The Environmental Protection Agency is supporting this study with interagency energy research and development funds.

Study Title: Development of Methods and Standards
of Operation During Oil and Gas Develop-
ment on Refuges

Organization: Research and Planning Consultants,
Inc., Austin, Texas

Investigator: Wayne Brown
Biological Services Project Officer: Richard Wade
Date: 10/76 - 10/78

The objective of this study is to provide information that will assist in the development of standards of operation to safeguard fish and wildlife resources and habitat during all phases of oil and gas development on refuges. This objective is being accomplished by studying coastal refuges in southeastern United

States, which have had ongoing oil and gas production and where a variety of stipulations were employed during the course of the development. These stipulations and their effects will be analyzed and evaluated for the development of recommendations that are effective in protecting fish and wildlife and are in the national interest. This study will result in an illustrated handbook depicting the various methods or standards of operation to protect fish and wildlife and will include a technical report evaluating these practices. The final report should be available in late 1977.

STREAM ALTERATIONS PROJECT STUDIES

Research projects are designed to develop methods or models to predict the impact of various kinds of stream channelization on aquatic and wildlife habitats. The work will help the Fish and Wildlife Service provide the best possible technical advice and recommendations to construction agencies undertaking new projects.

Completed Studies

Study Title: Effects of Stream Channelization and Bank Stabilization on Warmwater Sport Fish in Iowa

Organization: U.S. Fish and Wildlife Service, Iowa Cooperative Fishery Research Unit, Iowa State University, Ames

Investigator: Ross V. Bulkley

Biological Services Project Officer: Norman Benson

Date: 6/73 - 5/76

The objectives of this study were to determine the extent and location of channelization projects in the major river systems of Iowa and the effects of various types of bank stabilization and stream improvement structures (i.e., structures designed to improve fish habitat) on physical features of the stream. Also studied were the production of sport fish and their food organisms and the effects of long-reach and short-reach channelization work on the distribution and abundance of fish.

Information on past channelization was abstracted from State and Federal agencies' files. Four types of bank stabilization structures installed for highway protection were studied. Physical and biological characteristics were compared on short- and long-reach channelization projects.

Published reports include:

- "A Study of the Effects of Stream Channelization and Bank Stabilization on Warm Water Sport Fish in Iowa: Subproject No. 1. Inventory of Major Stream Alterations in Iowa." FWS/OBS-76/11.
- "A Study of the Effects of Stream Channelization and Bank Stabilization on Warmwater Sport

Fish in Iowa: Subproject No. 2. A Study of the Impact of Selected Bank Stabilization Structures on Game Fish and Associated Organisms." FWS/OBS-76/12.

- "A Study of Effects of Stream Channelization and Bank Stabilization on Warmwater Sport Fish in Iowa: Subproject No. 3. Some Effects of Short-Reach Channelization on Fishes and Fish Food Organisms in Central Iowa Warm Water Streams." FWS/OBS-76/13.
- "A Study of the Effects of Stream Channelization and Bank Stabilization on Warmwater Sport Fish in Iowa: Subproject No. 4. The Effects of Long-Reach Channelization on Habitat and Invertebrate Drift in Some Iowa Streams." FWS/OBS-76/14.
- "A Study of the Effects of Stream Channelization and Bank Stabilization on Warmwater Sport Fish in Iowa: Subproject No. 5. Effects of Long-Reach Stream Channelization on Distribution and Abundance of Fishes." FWS/OBS-76/15.
- "Warm Water Stream Alteration in Iowa: Extent, Effects on Habitat, Fish, and Fish Food, and Evaluation of Stream Improvement Structures (Summary Report)." FWS/OBS-76/16.

Study Title: Effects of Stream Channelization on the Fisheries Resources of the St. Regis River in Montana

Organization: U.S. Fish and Wildlife Service, Montana Cooperative Fishery Research Unit, Montana State University, Bozeman

Investigator: Richard Gregory

Biological Services Project Officer: Norman Benson

Date: 6/73 - 7/76

The objectives of this study were to determine the effect of past, present, and future channelization on the St. Regis River and its fishery. Results are contained in this report "Evaluation of Channelization and Mitigation on the Fishery Resources of the St. Regis River, Montana," FWS/OBS-76/06.

The approach was to measure the major biological, physical, and chemical characteristics of channelized and unchannelized portions of the river and evaluate the sport fishery use in specific areas before, during, and after channelization. The effectiveness of mitigating structures in rehabilitating fish habitat was also appraised.

Study Title: Effects of Channelization on Fisheries, Limnology, and Furbearers in the Luxapallila River in Alabama and Mississippi

Organization: Mississippi State University, Department of Wildlife and Fisheries, Starkville

Investigators: Dale H. Arner

C. H. Clemmer

Biological Services Project Officer: Norman Benson

Date: 6/73 - 12/76

This project is a baseline study to determine the chemical, physical, and biological characteristics of unchannelized, newly channelized, and old (over 40 years) channelized sections of the Luxapalila River.

Physical and chemical characteristics were measured. These included water velocity, hardness, pH, dissolved oxygen and CO, temperature, and turbidity. Biological characteristics included plankton, benthos, fish species composition and diversity, and furbearers. Results are summarized in the report titled "Effects of Channelization of the Luxapalila River on Fish, Aquatic Invertebrates, Water Quality, and Furbearers," FWS/OBS-76/08.

Continuing Studies

Study Title: Investigation of Unchannelized and Channelized Swamp Stream Habitats in North Carolina

Organization: U.S. Fish and Wildlife Service, North Carolina Cooperative Fishery Research Unit, North Carolina State University, Raleigh

Investigator: Melvin T. Huish

Biological Services Project Officer: Norman Benson

Date: 6/73 - 3/77

Objectives are to determine population levels of the major fish species in swamp stream environments; how various chemical, physical, and biological characteristics are related to sport fish and how channelization affects these relations; detailed life history information about selected species of fish; and the extent that swamp streams are utilized by anadromous fish.

Three North Carolina streams with varying degrees of channelization activity have been studied. The final report is being edited.

Study Title: Evaluation of the Effects of Stream Channelization on Warmwater Fish Populations in Ohio and Indiana

Organization: U.S. Fish and Wildlife Service, Ohio Cooperative Fishery Research Unit, Ohio State University, Columbus

Investigator: Bernard L. Griswold

Biological Services Project Officer: Norman Benson

Date: 6/73 - 2/78

Objectives are to determine the impact of channelization on warmwater fisheries and estimate the time needed for streams to recover; evaluate different methods of channelization (one bank cleared and sloped, use of fish deflectors, and uncleared stream banks) on fish populations; and determine the effect of channelization on fish populations and sport fishing in urban streams.

Channelized and unchannelized sections of study streams were sampled for fish and fish food organisms over a 3-year period. Physical characteristics of the streams were measured to determine differences in

temperature, water velocity, bank stability, sedimentation, and maximum and minimum stream discharges.

Study Title: Dynamics of Wetland Forests Under Changing Hydrologic Conditions—Wetlands Forest Model, Arkansas

Organization: U.S. Geological Survey, Reston, Virginia

Investigator: Richard Phipps

Biological Services Project Officer: James Brown

Date: 6/73 - 7/78

Objectives are to determine the relationship between flooding and forest reproduction, hydrological factors and growth of major wetland species, and develop a computer simulation model to determine the effects of various flooding patterns on wetland forests.

Information concerning growth rates of trees will be obtained by collecting, measuring, and analyzing increment cores from a number of species growing in a range of sites selected by examination of current and past flood patterns. Sample plot data will be obtained to determine forest reproduction under various flooding patterns. A computer simulation program will be developed to predict forest vegetation growth in which flood frequency, flood duration, and other hydrologic data will be used as inputs.

Refinement and testing of the computer model have continued. Tree ring width measurements were obtained from Neotoma, Ohio, supplementing records from three National Wildlife Refuges: the White River, Great Dismal Swamp, and Montezuma.

Study Title: Atchafalaya Basin Land and Water Management Study, Louisiana

Organizations: U.S. Fish and Wildlife Service, Louisiana Cooperative Wildlife and Fishery Research Units, Louisiana State University, Baton Rouge
University of Southwestern Louisiana, Lafayette
U.S. Geological Survey, Bay St. Louis, Mississippi

Investigators: John Newsom

Charles F. Bryan

Richard Hoes

Mark Konikoff

Biological Services Project Officer: Ellison Madden

Date: 7/73 - 6/77

The following ecological studies have been or are being funded or supervised by the Fish and Wildlife Service: (1) Woody vegetation—trends of succession in the past for purposes of prediction; (2) understory vegetation—succession of herbaceous and woody plants; (3) non-game woodland, raptor, and wading birds—abundance and distribution; (4) herpetofauna—turtles, snakes, amphibians, and reptiles; (5) crawfish—factors influencing production of the large (over \$3,000,000) commercial fishery; (6) wildlife production and distribution—deer and other game

species; (7) fish distribution and abundance within the Basin; (8) fish distribution and abundance in the adjacent estuary; (9) water quality—chemical and physical attributes; (10) benthos and plankton distribution and abundance; (11) flow/sediment modeling; and (12) influence of soil deposits on wildlife habitat.

These studies represent a portion of an overall-coordinated interagency study to document the complex relationships existing between hydrology, water quality, sedimentation, vegetation succession, and fish and wildlife populations. Approximately 15 individual studies have been initiated and are in various stages of completion. Completed reports include: "Study of the Life History and Ecology of the Red Swamp Crawfish, *Procambarus clarkii*, in the Lower Atchafalaya Basin Floodway," and "Trend Analysis of Vegetation in Louisiana's Atchafalaya River Basin."

Study Title: Effects of Channelization on Aquatic and Terrestrial Animals and Habitats in the Buena Vista Marsh

Organization: U.S. Fish and Wildlife Service, Cooperative Fishery Research Unit, University of Wisconsin, Stevens Point

Investigators: Daniel W. Coble
Raymond K. Anderson

Biological Services Project Officer: Norman Benson
Date: 6/74 - 3/77

Objectives are to determine the effects of channelization and drainage of the Buena Vista Marsh on terrestrial and aquatic habitats and their associated fish and wildlife populations.

Measurements of aquatic habitats will include: stream morphology, substrate and vegetation in streams and adjacent sheet water areas; standing crop and productivity of brook trout in unchannelized, recently channelized, and old channelized stream sections; populations and distribution of non-game fish; rate of recovery of normal stream morphology following channelization; and density of stream benthic macroinvertebrates in relation to substrate composition, stream vegetation, and trout populations.

Terrestrial measurements will include: species and population levels of birds, mammals, reptiles, and amphibians in and adjacent to unchannelized, recently channelized, and old channelized stream sections; effects of dredging on amount and longevity of temporary flooding (sheet water) during snow melt and spring rains; and use of sheet water and importance of associated invertebrates to feeding habits of various species of waterfowl.

The following documents have been completed:

- "Effects of Stream Channelization on Fish Populations in the Buena Vista Marsh, Portage County, Wisconsin," FWS/OBS-76/24.
- "Effects of Stream Channelization on Terrestrial Wildlife and Their Habitats in the Buena Vista Marsh, Wisconsin," FWS/OBS-76/25.

- "Effects of Stream Channelization on Aquatic Macroinvertebrates, Buena Vista Marsh, Portage County, Wisconsin," FWS/OBS-76/26.

Study Title: Effects of Channelization on Benthic Organisms and Aquatic/Riparian-Associated Wildlife in Selected Vermont Streams

Organization: U.S. Fish and Wildlife Service, Massachusetts Cooperative Wildlife and Fishery Research Units, University of Massachusetts, Amherst

Investigators: Wendell E. Dodge
Roger J. Reed

Biological Services Project Officer: Gerald Taylor
Date: 6/74 - 5/77

Objectives are to determine the impact of emergency authorized channelization on the terrestrial and aquatic resources of the White Watershed, Vermont.

Terrestrial studies are to develop, test, and use photogrammetric techniques to identify and classify changes in the White River Watershed caused by channelization; to develop population estimates of aquatic and riparian-associated wildlife in altered and unaltered sections of the stream; to develop statistical methods for estimating wildlife populations with photogrammetric data; and to propose mitigation for altered riparian ecosystems.

Aquatic studies are to measure aquatic insect diversity and seasonal abundances in channelized and unchannelized sites in four Vermont river systems; measure and analyze chemical and physical data in each river system; and assist the Division of Fisheries Services in collecting and processing benthic data from sites throughout the State. Field studies have been completed and a report published entitled "Channelization Assessment, White River, Vermont: Remote Sensing, Benthos and Wildlife," FWS/OBS-76/07.

Study Title: Project A - The Biological and Economic Impact of Stream Alteration Work Along Tributaries of the Roanoke River, Virginia
Project B - The Impact of Stream Alteration Along Tributaries of the Roanoke River, Charlotte, Virginia

Organizations: Virginia Polytechnic Institute and State University, Blacksburg Virginia, Cooperative Fishery Research Unit (Project A)

Virginia Cooperative Wildlife Research Unit (Project B)

Investigators: Burd S. McGinnes
James B. Whelan
Eugen O. Maughan

Biological Services Project Officer: Gerald Taylor
Date: 6/74 - 7/77

Project A

The objective is to determine the effects of time since channelization on selected physical and biological

cal characteristics of the stream and to determine benefits and costs of stream channelization.

Stream silt load, sinuosity, riffle-pool ratios, bottom types, stream cover, water temperature, and stream flow are being related to species composition and population levels of fish and benthos. Benefits and costs will be estimated using data from the Soil Conservation Service, Corps of Engineers, and State Game and Fish files.

Physical factors are being measured on a continuing basis and fish sampling is proceeding on schedule.

Project B

The objective is to determine the effects of time since channelization on vegetation and insect and wildlife populations.

The approach is to measure several characteristics of riparian vegetation along channels of various ages and relate these measurements to bird, mammal, and insect populations.

Study Title: Effects of Channelization on Fish and Invertebrate Populations and Habitat in the Logan River, Utah

Organization: U.S. Fish and Wildlife Service, Utah Cooperative Fishery Research Unit, Utah State University, Logan

Investigators: Richard S. Wydoski
William T. Helm

Biological Services Project Officer: Norman Benson

Date: 6/74 - 7/77

Objectives are to determine changes in the physical environment and in fish and invertebrate populations following channelization of the Logan River.

The investigators will: measure population levels and production of fish and invertebrates in altered and unaltered sections of the river at various time intervals following channelization; follow changes in the physical features of the stream bed and in vegetative cover along the streambank after alteration; define more fully the ecological requirements of brown trout and mountain whitefish; and provide alternatives or modifications for existing methods of channelization to minimize adverse effects on fish and wildlife.

Mapping of physical features has been accomplished and sampling of fish and invertebrates is being conducted as scheduled.

Study Title: Effects of Channelization of White River, Vermont, on Fish Habitat and Fish Populations

Organization: U.S. Fish and Wildlife Service, Fisheries Services, Region 5, Newton Corner, Massachusetts

Investigators: Fish and Wildlife Service staff in Montpelier, Vermont

Biological Services Project Officer: Gerald Taylor

Date: 6/74 - 12/78

This is an extension of a completed contract to the University of Massachusetts where the effects of stream alteration on birds, mammals, and vegetation were described and which included the preparation of habitat maps of the area. This study will evaluate the effects of the removal of stream cover and riparian vegetation on trout abundance and reproduction. Data over a 6-year period will be used. Effects on water quality and benthos will also be addressed.

Study Title: Effects of Stream Channelization on the Riparian Community, Iowa

Organization: U.S. Fish and Wildlife Service, Iowa Cooperative Wildlife Research Unit, Iowa State University, Ames

Investigators: Robert B. Dahlgren
Louis B. Best

Biological Services Project Officer: Charles A. Segelquist

Date: 3/75 - 7/78

This work will provide information on short- and long-term effects of stream channelization on land use practices and on plant, avian, and mammalian communities. Data will be collected on: changes in land-use of old stream meanders by-passed by channelization; composition and structure of the riparian plant community under pre- and post-channelization conditions; composition and density of avian and mammalian communities under pre- and post-channelization conditions; and relationships between changes in plant communities and bird and mammal populations as the result of channelization.

Land use practices and changes in vegetation composition will be determined from aerial photographs. Vegetative, avian, and mammalian censuses will be conducted in eight study areas in 1976 and 1977. Land use practices and vegetation photogrammetric analyses have been completed on 76 channelization projects. First summer's field studies (vegetative, avian, and mammalian census) have been completed.

Study Title: Application of Remote Sensing to Wildlife Habitat Analysis on the Mississippi River Floodplain Between Hasting, Minnesota, and Cairo, Illinois

Organization: University of Minnesota, St. Paul

Investigator: Merle P. Meyer

Biological Services Project Officer: Richard Huber

Date: 6/75 - 3/77

This project will develop a series of maps from aerial photos showing aquatic and terrestrial cover types as well as man-made physical structures within the Mississippi River floodplain from the head of navigation at Minneapolis, Minnesota, to the confluence with the Ohio River at Cairo, Illinois.

Vegetation type maps will be prepared from aerial photographs supplied by a subcontractor. Personnel have been hired and trained. The aerial photographs

have been acquired and ground-truthed. Type mapping is underway.

Study Title: Ecological Evaluation of Bank Stabilization and Channelization Work on the Missouri River

Organization: U.S. Fish and Wildlife Service, North Central Reservoir Investigation, Yankton, South Dakota

Investigator: Charles Walburg

Biological Services Project Officer: Norman Benson

Date: 6/75 - 7/77

The objectives of this study are to determine: the species and sizes of fish utilizing various stream habitat types by season; water current and fish food abundance in various habitat types by season; critical water velocities (velocities at which fish can no longer retain their position in the current) and fatigue times (about 60-90% of critical velocity) of 16 common fish species in the Missouri River; and the value and use of various habitat types in unchannelized and channelized sections of the river for mammals, birds, and reptiles.

Field data will be collected in various aquatic and terrestrial habitats to predict the effects of future changes in man-created habitats. Laboratory studies will provide data on current tolerances of fish. Most of the data were collected during FY 1976.

Study Title: Floral and Faunal Changes in Lowland Hardwood Forest Resulting from Channelization, Drainage, and Impoundment in Missouri

Organizations: U.S. Fish and Wildlife Service, Missouri Cooperative Wildlife Research Unit, University of Missouri, Columbia Gaylord Memorial Laboratory, Puxico, Missouri

Investigators: Thomas S. Baskett

Leigh H. Fredrickson

Biological Services Project Officer: James Brown

Date: 6/75 - 7/77

Objectives are to identify the effects of channelization, drainage, and green tree (annually flooded) impoundments on the species composition, density, diversity, re-establishment, and growth of plants (trees, shrubs, and herbs) in lowland hardwood communities; evaluate methods for vegetation and animal assessment; predict the effects of channelization, drainage, and impoundments on mammals, birds, reptiles, and amphibians; and determine the relationships between plant and animal communities as the result of channelization, drainage, and impoundment.

The effects of channelization will be examined at four study sites on the St. Frances River. Three sites on the Mingo National Wildlife Refuge will be studied to examine drainage and impoundment effects.

Study and control sites have been selected. Transects have been established on the Mingo control

impoundment and drainage sites; seedlings, shrubs and herbs will be sampled, and amphibians, reptiles, tracks, and scats enumerated. Data have been collected on study sites and work is progressing on schedule.

Study Title: Feasibility and Environmental Effects of Modifying Side-Channel Openings on the Upper Mississippi, Minnesota

Organizations: Winona State College, Winona, Minnesota, and St. Mary's College, Winona, Minnesota

Investigators: Calvin R. Fremling

David R. McConville

Biological Services Project Officer: Richard Huber

Date: 6/75 - 6/78

Objectives are to determine the ecological consequences of providing freshwater flows to backwater areas by modifying side-channel openings of the main stream of the Mississippi River, and to develop models which can be used to predict the results of similar side-channel openings in other areas along the river.

The approach is to document changes that have occurred in physical features in and around backwater areas that have been cut off from the river; measure rate of water exchange following creation of side-channel openings; record changes that occur after construction of side-channel openings in water quality, terrestrial and aquatic vegetation, phytoplankton, periphyton, benthos, and fish and wildlife populations; and record recreational and commercial use.

Pre-construction baseline data were collected on the three original backwater areas under study—West Newton Chute, Fountain City Bay, and Sam Gordy's Slough. Baseline data collection is underway for two additional studies that were added during the summer of 1976—Belvidere and Blackbird sloughs. Winter data will be collected during 1977.

Study Title: Stream Channel Modification (Channelization) in Hawaii and Its Environmental Effects on Native Fauna

Organization: U.S. Fish and Wildlife Service, Hawaii Cooperative Fishery Research Unit, University of Hawaii, Honolulu

Investigator: John A. Maciolek

Biological Services Project Officer: Norman Benson

Date: 6/75 - 7/78

Objectives are to compile a state-wide inventory of the extent and nature of channel modification and the complement of native biota in respective streams by consulting agency records and conducting field surveys; measure turbidity, temperature, conductivity, species diversity, and relative abundance of key macrofaunal species (fish and benthos) in selected channelized and pristine streams; and study selected endemic aquatic species to determine their tolerance to temperature variation, exposure stress (illumination and cover), and migrational behavior under channelization conditions.

Field investigation includes a state-wide inventory (already completed) of channel modifications on perennial streams, a general biota survey, environmental monitoring, and aquatic community assessment. Tolerance and behavior will be investigated in laboratory experiments.

Study Title: Gravel Removal Studies from Arctic and Sub-Arctic Streams in Alaska

Organization: Woodward-Clyde Consultants, Anchorage, Alaska

Investigator: Erich H. Follman

Biological Services Project Officer: Norval Netsch

Date: 6/75 - 7/79

The overall objective is to provide an information base that will assist resource managers in formulating operational recommendations that will minimize detrimental environmental effects of gravel removal from arctic and sub-arctic streams. The Environmental Protection Agency is contributing to this study with interagency energy research and development funds.

The study approach is to determine physical, chemical, and biological characteristics of three selected areas before, during, and after gravel removal; determine gross physical, chemical, and biological characteristics of approximately 30 existing gravel removal sites that reflect a variety of mining methods, time since gravel removal, and stream types; determine in moderate detail on a short-term basis, physical, chemical, and biological characteristics of 12 selected sites where fishery resources are known to exist following gravel mining; and determine what gross relationships exist between gravel removal operations, geomorphic characteristics of streams water quality, and biota.

Accumulation and assimilation of background information has been completed on the 74 sites under consideration for study site selection. Study site selection is partially completed, and eight sites are under study. Additional sites will be selected and studied during FY 1977 and 1978. A preliminary report has been issued and is titled "Gravel Removal Studies in Selected Arctic and Sub-Arctic Streams in Alaska", FWS/OBS-76/21.

New Studies

Study Title: Impact of Stream Alteration on Riparian Vegetation, Birds, Mammals, Reptiles, and Amphibians in Selected Habitats of the South Central United States

Organization: Oklahoma State University, Research Foundation, Stillwater

Investigator: John Barclay

Biological Services Project Officer: Joseph Kathrein

Date: 2/76 - 7/78

For environmental assessment, quantitative data will be collected to predict the consequences of stream alteration on riparian vegetation and birds, mammals,

reptiles, and amphibians in grassland habitats of Oklahoma. Sample sites have been selected on altered and unaltered riparian sites and on adjacent upland areas. Factors to be studied include: composition and structure of plant communities; seasonal use of sites for breeding, feeding, or migration of birds and mammals; and seasonal abundance of birds, mammals, reptiles, and amphibians. Guidelines will be developed for environmental assessment and mitigation of impacts. Personnel have been hired, and permission for access to study sites has been granted by landowners. Plant community, bird and mammal studies are underway.

WESTERN WATER ALLOCATION PROJECT STUDIES

Research is supporting the project's objectives to establish fish and wildlife priorities for western rivers and streams, to determine the water quantity needs of fish and wildlife in energy development areas, and to find better ways of integrating energy development with fish and wildlife interests. The studies below are directed to these objectives.

Completed Studies

Study Title: Critical Appraisal of Research Needs with Respect to Fish and Wildlife Implications of Western Water Allocation for Energy Development

Organization: University of Colorado, Institute of Behavioral Science, Boulder

Investigators: William B. Lord
Gilbert F. White

Biological Services Project Officer: Robert Hayden

Date: 6/75 - 1/76

This study identifies critical research needs for improving decision making in water allocation for the upper Missouri River basin. Support is being provided by the Environmental Protection Agency with interagency energy research and development funds.

The work involved definition of policy issues, establishment of information requirements, determination of information availability, evaluation of research needs, preparation of discussion documents, review of documents through conference of government and academic specialists, and preparation of a final report titled "Fish and Wildlife Implications of Upper Missouri Basin Water Allocation: A Research Assessment," FWS/OBS-76/04. The study was conducted by a multi-disciplinary team from the fields of anthropology, biology, civil engineering, economics, geography, geology, law, and political science.

Study Title: Instream Flow Requirements: State-of-the-Art

Organization: Utah State University, Logan

Investigator: John A. Kadlec

Biological Services Project Officer: Robert Hayden
Date: 6/75 - 2/76

This study was a first step to develop a comprehensive methodology or series of methodologies for determining instream flows for the following purposes: aquatic life, water quality, estuarine inflow, recreation, general environment, aesthetics, and wildlife. The Environmental Protection Agency is contributing to this study. The work is divided into two tasks:

1. An evaluation of the efficiency and effectiveness of existing methodologies. Each methodology is critiqued on its shortcomings and limitations. The study team indicated where additional work was needed in terms of the purposes listed above.
2. Based on the needs identified in Task 1, the study defines promising avenues for approaching the development of a comprehensive methodology. In addition, it assessed the approaches, feasibility, and manpower funding needs that would be involved in producing a comprehensive methodology.

A report was produced on the state-of-the-art and on the feasibility of developing new methodologies. The report is "Methodologies for the Determination of Stream Resource Flow Requirements: An Assessment," FWS/OBS-76/03.

Study Title: Survey of Existing Conditions Below Dams and Diversions in the West

Organizations: Jones & Stokes, Inc., Sacramento, California, and Enviro Control, Inc., Rockville, Maryland

Investigators: Charles Hazel
Wayne Nelson

Biological Services Project Officer: Harvey Doerksen
Date: 7/75 - 9/76

This project was an audit of approximately 100 dams and diversions to identify the instream flow needs methodology used by the biologist, to identify institutional cooperation or constraints in the implementation phase, and to identify the actual impact of altered flows on fish and wildlife.

Final reports include:

- "Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife, Part A: Rocky Mountains and Pacific Northwest," Executive Summary, FWS/OBS-76/28.
- "Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife, Part A: Rocky Mountains and Pacific Northwest," Final Report, FWS/OBS-76/29.
- "Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife, Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region Case Studies," FWS/OBS-76/30.

- "Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife, Part A: Rocky Mountains and Pacific Northwest, Pacific Northwest Region Case Studies," FWS/OBS-76/31.
- "Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife, Part B: California," Executive Summary, FWS/OBS-76/32.
- "Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife, Part B: California," Final Report, FWS/OBS-76/33.
- "Assessment of Effects of Altered Stream Flow Characteristics on Fish and Wildlife, Part B: California," Case Studies, FWS/OBS-76/34.

Continuing Studies

Study Title: Evaluation of the Effects of Reduced Stream Flow upon Trout Populations, Phase II: Field Validation Studies

Organization: Utah State University, Logan

Investigator: John Kadlec

Biological Services Project Officer: Kent Andrews

Date: 6/75 - 6/77

In an effort to evaluate the impact of reduced flow on trout populations, the contractor will undertake several specific studies:

- A study of macroinvertebrates of the upper Strawberry River.
- A study of primary production in the upper Strawberry River.
- A laboratory study of anchor and frazil ice formation.
- A field study of anchor and frazil ice formation in the Logan River.

These studies are cosponsored with the Environmental Protection Agency and the Bureau of Reclamation. Reports on the findings of each specific study will be submitted along with a summary report of incomplete investigations of general significance.

Study Title: Investigations of the Implications of Yellowstone River Flow Reservations in Montana

Organization: Montana Fish and Game Department, Billings

Investigator: James Posewitz

Biological Services Project Officer: Kent Andrews

Date: 6/75 - 6/78

The contractor will conduct an investigation of the implication from various levels of flow reservations in the Yellowstone River of Montana. The river will be a test bed in applying existing methodologies and developing new methodologies for determining the instream flow needs of the present aquatic communities. These communities cover the upper cold-water zone, the middle transition zone, and lower warm-

water zone. The project will also integrate and coordinate extensive ongoing work sponsored by the State and Federal agencies on the Yellowstone River.

Study Title: Agricultural-Fish and Wildlife Research Program on the Columbia Basin Project

Organization: Washington State Department of Game, Yalsima

Investigator: Wendell Olliver

Biological Services Project Officer: Bob Cleary

Date: 6/75 - 6/80

The objectives of this project are to determine major irrigation project features which result in long-term fish and wildlife benefits and losses. This cooperative effort with the Bureau of Reclamation, Office of Water Research and Technology, Washington State University, and Washington State Department of Game will help to assure that the enhancing features are included and the degrading features eliminated or mitigated in future projects. The project also evaluates the social, economic, and political costs and benefits associated with increased wildlife production. The primary users of the information developed will be the Fish and Wildlife Service, the Bureau of Reclamation, and irrigation districts in future project planning and contract negotiations.

New Studies

Study Title: Comparison of Instream Flow Methodology

Organization: Colorado State University, Department of Fishery and Wildlife Biology, Fort Collins

Investigator: Clair Carlson

Biological Services Project Officer: Harvey Doerksen

Date: 5/76 - 5/77

This study is cosponsored by the Bureau of Land Management and is designed to conduct field applications of four selected methodologies for determining instream flow requirements. Two of the methods require minimal field work while the other two involve considerable field measurement. All methodologies will be compared against each other in terms of cost, time, level of effort, and how well they predict minimum-flow conditions. The study will be accomplished on the Yampa and White Rivers in Colorado.

Study Title: Upper Missouri Reservoir Investigations

Organization: U.S. Fish and Wildlife Service, North Central Reservoir Investigations, Pierre, South Dakota

Investigator: William Nelson

Biological Services Project Officer: Lee Ischinger

Date: 5/76 - 5/78

The purpose of this project is to identify the probable energy-impact areas in Fort Peck and Garrison reservoirs, conduct limnological baseline studies, and predict the effects of energy development

in those reservoirs. Based on information derived from this study, recommended strategies, criteria, and guidelines will be synthesized to provide practical development alternatives, mitigate losses, and utilize development-related environmental modifications to enhance water quality and fish and wildlife habitat. The Environmental Protection Agency is contributing to this study.

The chemical, physical, and biological limnology of the study reservoirs will be measured and a study plan developed to fill identified data gaps. Known and anticipated aquatic environmental impacts associated with energy development will be identified. In addition, the ecological similarities and differences between the subject reservoirs and other main stem Missouri reservoirs will be determined.

In order to rank impacts, an energy-impact matrix integrating the relationships between various levels and intensities of energy development and the resulting cumulative effects will be developed. The final report will contain recommendations for energy and energy-related development on the subject reservoirs.

Study Title: Stream Evaluation Study

Organization: 17 Western States

Investigator: Separate investigator in each State

Biological Services Project Officer: Kent Andrews

Date: 6/76 - 7/77

This project will rank all waters in the western States according to their importance for fish and wildlife. Four ranking classifications will be used varying from critical value to low value for fish. The same classification system will be used in all States. The States will document the reasons for each stream classification assigned. The Environmental Protection Agency is supporting this study with interagency energy research and development funds.

Color coded maps for each State illustrating the stream classifications at a scale of 1:500,000 will be developed along with documentation of the basis for placing each stream in a specific value classification. An atlas of maps showing the relative value of each stream in several map scales commonly used in planning will also result from this study.

Study Title: Land Use/Habitat/Fishery Evaluation

Organization: U.S. Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah

Investigator: William Platt

Biological Services Project Officer: Robert Raleigh

Date: 7/76 - 6/77

This project will evaluate the relationship between habitat variables and fishery populations, correlate streamside habitat type and geomorphic land classifications to fishery populations, and evaluate the impact of livestock grazing on riparian vegetation and channel stability and the subsequent impact to the

fishery. This study will aid in instream flow methodology development and aquatic habitat assessment. The completion report will analyze data regarding stream flow/fishery relationships, habitat-classification variables, and livestock grazing/stream-habitat relationships.

Study Title: Instream Flow Strategies

Organizations: Enviro Control, Inc., Rockville, Maryland, and Dewsnap and Jensen, Salt Lake City, Utah

Investigators: Enviro-Wayne Nelson

Dewsnap-Richard L. Dewsnap, Dallin Jensen

Biological Services Project Officer: Harvey Doerksen

Date: 8/76 - 8/77

The study will identify all existing procedural, methodological, and legal means for reserving flows for enhancing fish and wildlife, and will evaluate the effectiveness of these means for reserving flows as tools for use by State or Federal fish and wildlife agencies. In addition, the study is designed to determine the amount of unobligated waters in Federal reservoirs and determine the extent to which such waters may be available to ensure downstream flows for fish and wildlife.

The result will be a matrix for each western State summarizing pertinent information for each strategy of reserving flows. The matrices will include: legal basis for the strategy; administrative procedures and decision points for implementing it; costs; typical problems and constraints; and an estimate of usability and who can utilize the strategies. The Environmental Protection Agency is supporting this study with interagency energy research and development funds.

Study Title: Methodology Development for Water Availability Assessment

Organization: Pan Technology, Washington, D.C.

Investigator: Allen Muir

Biological Services Project Officer: Robert Hayden

Date: 9/76 - 3/77

Water availability assessments are required under Section 13 of the Federal Non-nuclear Energy Research and Development Act for various energy technologies, demonstration projects, and commercial applications. The assessments must also include an analysis of the environmental effects of dedicating this water to energy use. During FY 1976 the Western Water Allocation Project worked with the Energy Research and Development Administration and the Water Resources Council to determine the Service's role in these three types of assessments. As the next step in this continuing process, the Water Resources Council has contracted with the Service to develop the methodology for determining instream flow needs in water assessments required under Section 13(a). The project will define the data base required to provide for the protection and propagation of fish, shellfish, and

wildlife. A handbook will be written to describe the methodologies and procedures for application in water assessments performed under Section 13(a).

Study Title: Resources for the Future Forum on the impact on Western Water, Fish, and Wildlife of Energy Development in the Upper Colorado River Basin

Organization: Resources for the Future, Inc., Washington, D.C.

Investigator: Allen Kneese

Biological Services Project Officer: Robert Hayden

Date: 10/76 - 6/77

The purpose of this contract was to develop and present a forum bringing together experts on the Colorado River. The forum was held in October 1976 in Albuquerque, New Mexico. Papers were presented and discussion was encouraged to identify for the Fish and Wildlife Service the priority research needs relating to fish and wildlife resources in the basin. The formal papers will be published by Resources for the Future and will illustrate and encourage broad recognition of the problem areas facing the Service. This book will serve as the basis for future program development for the Western Water Allocation Project and will also serve to provide a national focus on the water problems associated with energy development in the Upper Colorado River Basin. Support for this study is being provided by the Environmental Protection Agency with interagency energy research and development funds.

GEOHERMAL, OIL SHALE, AND MINERALS PROJECT STUDIES

To help guide the development of geothermal energy, the Biological Services Program is supporting ecological studies and formulating guidelines to ensure protection and enhancement of fish and wildlife resources at power generation sites. The work includes establishing precise monitoring programs for the development and operation of geothermal facilities. A program to identify and meet these requirements will be presented in the following studies.

Studies started in FY 1975 will contribute to a systems analysis of the effects of a mature oil shale industry on fish and wildlife. Until now, no analysis of this nature has been attempted.

The studies include investigations of the overall programmatic aspects of large-scale oil shale development, land and habitat restoration, plant materials for rehabilitating spent shale, and the effects of water diversion to land reclamation from irrigation.

The minerals aspect of this project is new, but should grow into a major part of the overall

effort. Initial studies deal with various aspects of the effect of phosphate mining on fish and wildlife resources.

Completed Studies

Study Title: Studies in Connection with the Ecological Effects of Geothermal Developments on the Natural Environment

Organization: Jones & Stokes Associates, Inc., Sacramento, California

Investigator: Robert Jones

Biological Services Project Officer: Willard Spaulding

Date: 6/75 - 6/76

The study produced the "Geothermal Handbook" and was composed of three work units:

- Geothermal assistance and monitoring guidance. Technical assistance was provided the Geothermal Project in defining the nature and extent of the environmental problems inherent in geothermal development. This effort included advice on existing methodologies and techniques for geothermal monitoring, assistance in field surveys, and establishing an effective data handling and information system.
- National geothermal program plan. The study analyzed activities in both the private sector and government agencies to integrate them into an overall development plan for geothermal energy. The plan included an assessment of technologies to be used and their environmental effects. In addition, the plan will help define critical wildlife habitats, and will indicate methods for minimizing adverse impacts upon fish and wildlife.
- Development of enhancement and mitigation manual. This manual is directed at creating opportunities for establishing new or improved habitats for fish and wildlife in the course of geothermal project development. The manual includes an assessment of geothermal project development and geothermal technologies and methods for overcoming adverse effects. It will be used by Fish and Wildlife Service personnel and by other agencies responsible for environmental protection.

Study Title: Development of a Program Analysis Concerning the Environmental Consequences of a Mature Oil Shale Industry

Organization: Thorne Ecological Institute, Boulder, Colorado

Investigator: Hubert Burke

Biological Services Project Officer: Joseph Blum

Date: 1/76 - 8/76

This study consisted of preparing a planning document that managers can use to make program decisions. The following specific tasks were involved:

- Defined a series of high-priority studies that were needed to provide information for decision making.
- Made a synopsis of the studies that will answer specific questions for decision making and provided sufficient guidance on scope and objectives so that requests for proposals for the research may be prepared.

The report is titled "Wildlife and Oil Shale: A Problem Analysis and Research Program, Volume I (Report); Volume II (Appendix)," FWS/OBS-76/01.

Continuing Studies

Study Title: Oil Shale Systems Modeling

Organization: U.S. Fish and Wildlife Service, Denver Wildlife Research Center, Fort Collins Field Station, Fort Collins, Colorado

Investigator: Jack E. Gross

Biological Services Project Officer: Edgar Pash

Date: 4/75 - 9/77

The purpose of this study is to construct and promote the use of a computerized simulation model as a decision making aid for planning and management of fish and wildlife resources in connection with oil shale developments. A computerized systems model will be assembled that will integrate the basic approaches and methodologies of the oil shale development process in a manner that will illustrate the physical requirements that the development will place on the natural physical resources. The ecological submodels that will summarize appropriate ecological impact information will be incorporated into the foregoing physical-impact model.

Study Title: Reversion of Irrigated Lands

Organization: U.S. Fish and Wildlife Service, Utah Cooperative Wildlife Research Unit, Utah State University, Logan

Investigator: David Anderson

Biological Services Project Officer: Edgar Pash

Date: 6/75 - 6/78

This study is designed to describe the vegetative successional responses and the related wildlife population changes on lands that revert from irrigated to non-irrigated status, a condition that may result as water is diverted from agricultural to energy uses.

Several reports will present the scientific findings of the project. In particular, two Master's theses will be summarized. Data collected during the study will be summarized in tabular form, field methods thoroughly documented, and modeling approaches described. A mathematical description of any simulation models developed will be presented to provide for easy interpretation.

Study Title: Plant Materials Center

Organization: U.S. Soil Conservation Service in cooperation with the U.S. Fish and Wildlife

Service, Region 6, Denver, Colorado
Investigator: Merritt D. Burdick
Biological Services Project Officer: Harold Boeker
Date: 6/75 - 6/85

This Cooperative Agreement will provide for the establishment and operation of a Plant Materials Center in Rio Blanco County, Colorado. The Center will play an important role in the restoration of western range lands disturbed through anticipated wide-scale energy development. It will also provide a field study base where methods of suitable plant species selection and establishment may be carried out.

Work on the new Center is progressing. Land has been acquired, office and warehouse structures erected, and irrigation systems installed. Initial plantings were made during the 1976 spring season.

New Studies

Study Title: Successional Patterns of Plant and Vertebrate Wildlife Communities on Western Irrigated Lands Reverted to Non-Irrigated Status

Organization: U.S. Fish and Wildlife Service, Cooperative Wildlife Research Unit, Utah State University, Logan

Investigator: David Anderson

Biological Services Project Officer: Edgar Pash

Date: 7/75 - 12/78

Sizable amounts of water will be required by a mature oil shale industry. For the production of 1 million barrels of oil per day, water estimates vary from 61,000 to 295,000 acre-feet per year. Currently, water in the upper basin of the Colorado River is appropriated primarily for agriculture. It is assumed that some of this water would be diverted to an oil shale industry, causing the irrigated land to revert to dry-earth status and having an impact upon wildlife communities.

Study Title: Mitigation Goal Alternatives for Oil Shale Development

Organization: U.S. Fish and Wildlife Service, Colorado Cooperative Wildlife Research Unit, Colorado State University, Fort Collins

Biological Services Project Officer: Edgar Pash

Date: 11/75 - 5/79

This project is designed to identify the most significant fish and wildlife population reductions that will result from environmental changes caused by oil shale development, formulate a list of candidate mitigation goal alternatives for oil shale development, and evaluate the effectiveness of a sample of previous attempts to mitigate wildlife population reductions.

The end product is expected to yield, for any selected species, a series of choices pertaining to the following decision elements:

- The number and kind of goal units that could be produced each year.

- Methods by which each goal might be obtained.
- Location where each method might be applied.
- Year when goal might be attained.
- Estimated cost of attaining each goal.

Study Title: Trace Substances in Wildlife Food Chains

Organization: Colorado State University, Fort Collins

Investigator: Julius Nagy

Biological Services Project Officer: Harry Coulombe

Date: 8/76 - 8/79

This study is focused on the trace substances that occupy the food chains related to wildlife in the Piceance Basin of Colorado. Information will be compiled on the food habits and food chains of the animal species and on elements which might be potentially toxic to wildlife. The study will also include an inventory of wildlife which might be affected by potentially hazardous materials in the environment. Data will be collected on trace element concentrations in animal tissues, in selected plant materials, and on actual or likely sources of trace mineral contaminations.

A summary report will be written to present information on occurrence, distribution, food habits, and major food chains of fauna occupying the Colorado Oil Shale Region; baseline information on natural levels of potentially toxic elements in plants and plant parts; and baseline information on potentially toxic elements in various tissues in vertebrate fauna of the Piceance Basin and those living in close association with spent oil shale deposits.

Study Title: Florida Phosphate Inventory

Organization: Archbold Biological Station, Lake Placid, Florida

Investigator: James N. Layne

Biological Services Project Officer: James Barkuloo

Date: 11/76 - 9/77

The Environmental Protection Agency is developing an environmental impact statement for the central Florida phosphate industry. The impact statement will be dealing with mining activities on private lands. However, Federal involvement is necessary because of the discharge permits required in the mining and processing operations. The Fish and Wildlife Service will cooperate with the Environmental Protection Agency in determining the impacts on the fish and wildlife resources located in the seven county area of central Florida (Polk, Hillsborough, Manatee, Hardee, DeSoto, Sarasota, and Charlotte).

Specific objectives are:

- To determine the species composition, area of occupation, and relative abundance of wildlife and fisheries resources.
- To determine endangered or threatened species which appear on either the Federal or State lists.
- To develop distribution maps and overlays that show the relationship between present and

proposed mining areas and various wildlife and fish species.

- To identify those species expected to be most impacted by phosphate mining, and the ultimate effects.

Study Title: Systematic Approach to Phosphate Mining in the United States

Organization: Production Automation, Inc., Boulder, Colorado

Investigator: William Ganter

Biological Services Project Officer: Arch Mehrhoff

Date: 12/76 - 10/77

The purpose of this study is to develop a system for modeling the Nation's phosphate mineral development to determine impacts on biological resources from various development scenarios. The model will serve as a long-range guide to systematic develop-

ment of phosphate resources which minimizes adverse impacts to fish and wildlife. This plan would include an analysis of the various mining techniques, rate and sequence of reserve development, transportation methodologies, legal implications, market conditions, and world trade procedures as they relate to fish and wildlife resources and other environmental aspects. The interactive model would be responsive to various scenarios that allow definitive options on how to develop the phosphate industry over a 25-year period. Subsystems or models would outline the rate and sequence of phosphate mining within the U.S. to achieve the optimum level for mining and wildlife resources. Impacts to fish and wildlife resources will be projected by a biological impact assessment model. The entire system will analyze impacts on each of the three currently proposed mine areas—the Osceola, Caribou, and Los Padres National Forests. Information would also be considered as to previously disturbed areas and proposed areas.

Appendix A

Office of Biological Services: Organization Chart¹

¹ Does not include Biological Services functions assigned to Fish and Wildlife Service regional offices or national wildlife research centers.

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Assistant Regional Director - Environment

RAL, Coastal Ecosystems
A/RAL, Coastal Ecosystems¹³
A/RAL, Outer Continental Shelf
RAL, Stream Alterations¹⁴
RAL, Power Plants
RAL, Coal
Regional Coordinator, National Wetland Inventory
Clerk-Typist¹¹
Clerk-Steno¹³

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James Kirkwood
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Assistant Regional Director - Environment

RAL, Coastal Ecosystems
RAL, Power Plants
RAL, Coal¹⁵
RAL, Stream Alterations
A/RAL, Coastal Ecosystems¹⁶
A/RAL, Outer Continental Shelf
Regional Coordinator, National Wetland Inventory

David Riley

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Assistant Regional Director - Environment

RAL, Energy
RAL, Western Water Allocation/Stream Alterations
A/RAL, Western Water Allocation
A/RAL, Coal/Power Plants
Oil Shale Coordinator¹⁷
Coal Coordinator, Montana & North Dakota¹⁸
Coal Coordinator, Colorado
Coal Coordinator, Wyoming¹⁹
Coal Coordinator, Utah
Regional Coordinator, National Wetland Inventory
Coal Environmental Impact Statement Specialist
Coal Environmental Impact Statement Specialist
Secretary¹
Clerk-Typist¹

John VanDerwalker

Harold Boeker
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Jeffrey Johnson
John Andrick
Donald Deitz
Raymond Hoem
Harold Tyus
Kent Keenlyne
vacant
Eugene W. Hansmann
Grady Towns
LeRoy Carlson
Denise Cheatum
Beverly Girard

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Anchorage, Alaska 99501
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Assistant Area Director - Environment

RAL, Coastal Ecosystems
A/RAL, Coastal Ecosystems²⁰
RAL, Stream Alterations
OCS Environmental Studies Coordinator
A/RAL, Outer Continental Shelf
Ecologist, Birds
Ecologist, Mammals
Project Leader, Shore Birds
Project Leader, Waterfowl
Project Leader, Pelagic Birds
Marine Biologist
Computer Systems Analyst
Regional Coordinator, National Wetland Inventory
Administrative Officer
Wildlife Biologist¹
Wildlife Biologist¹
Biological Technician¹
Biological Technician¹
Biological Technician¹²
Biological Technician¹²
Clerk-Typist¹²
Clerk-Typist¹²

Gary Hickman

Calvin Lensink
David Cline
Norval Netsch
vacant
Gerald Reid
Kenton Wohl
John Hall
Robert Gill
Robert Jones
Patrick Gould
Gerald Sanger
Robert Blanscepp
Arthur LaPerriere
Joy Bartlett
Craig Harrison
David Nyswander
Scott Hatch
Arthur Sows
Richard Moe
Colleen Handel
Norma Lee
Sally Fullerton

Key:

1. Permanent Part-time Employee
2. Intergovernmental Personnel Act Appointment
3. On detail from the Bureau of Outdoor Recreation
4. On detail from the Denver Wildlife Research Center
5. Located at the U.S. Army Engineers Waterways Experiment Station, Vicksburg, Miss. 39180, FTS: 542-3111 COMM: (601) 636-3111
6. On assignment from the U.S. Forest Service
7. Does not include Biological Services position assigned to research centers
8. Located at U.S. Fish and Wildlife Service, 4620 Overland Dr., Boise, Idaho 83705, FTS: 554-1931 COMM: 384-1931
9. Located at U.S. Fish and Wildlife Service, 2800 Cottage Way, Room E1837, Sacramento, California 95825, FTS: 468-4516
10. Located at Galveston Field Office, Rm 229 U.S. Post Office/Courthouse Bldg., 601 Rosenberg, Galveston, Texas 77550, FTS: 527-6112
11. Employed under ceiling of the Regional Director
12. Career Seasonal Employee
13. Mailing Address; P.O. Box 4696, Panama City, Florida 32401, Phone: (904) 769-5430
14. Located at National Coastal Ecosystems Team, Office of Biological Services, U.S. Fish and Wildlife Service, NSTL Station, Mississippi 39529, FTS: 964-2091 COMM: (601) 688-2091
15. Located at U.S. Fish and Wildlife Service, Office of Biological Services, Box 346, Elkins, W. Virginia 26241, FTS: 923-5323
16. Located at 1825 B Virginia Street, Annapolis, Md. 24401, COMM: 922-2007 (Annapolis Field Station)
17. Located at U.S. Fish and Wildlife Service, c/o U.S. Geological Survey, Mesa Federal Savings and Loan, 131 N. 6th - Suite 300, Grand Junction, Colorado 81501, FTS: 322-0281
18. Located at Federal Bldg. Rm. 3035, 316 N. 26th St., Billings, Montana 59101, FTS: 585-6360 COMM: (406) 657-6360
19. Located in Casper, Wyoming/Mailing Address P.O. Box 253, Casper, Wyoming 82602, FTS: 328-5446 COMM: (307) 265-5550
20. David Cline is on an Intergovernmental Personnel Act Appointment and is located at Office of the Governor, Division of Policy Development and Planning, Pouch AD, Juneau, Alaska 99811, COMM: 465-3541

Appendix B

PUBLICATIONS OF THE BIOLOGICAL SERVICES PROGRAM, JUNE 1977

Most of the studies related to the publications listed below were conducted under contract for the Biological Services Program or by members of the Biological Services staff. Other studies were sponsored in part by the Program in cooperation with Federal and State agencies and private organizations. The publications are available for purchase from the National Technical Information Service (NTIS) or other sources as indicated (see the end of this listing for NTIS address and price codes). Limited single copies of some publications are available from the Office of Biological Services in Washington, D.C., or from its National Teams. Information on availability is given for each of the items listed.

FOR GENERAL INFORMATION CONTACT:

Information Transfer Coordinator
Office of Biological Services (OBS)
Fish and Wildlife Service
U.S. Department of the Interior
Washington, D.C. 20240

FWS/OBS-76/02. ANNUAL REPORT OF THE BIOLOGICAL SERVICES PROGRAM, FISCAL YEAR 1975. Prepared by the Office of Biological Services. 48 pages. Available from NTIS as PB-251738. Price code: PC A04/MF A01.

Report on the first-year activities of the Program that gives a brief synopsis of 60 new studies being undertaken by the Program to seek solutions to ecological problems.

POWER PLANTS

For information contact:

Information Transfer Specialist
National Power Plant Team (NPPT)
U.S. Fish and Wildlife Service
1451 Green Road
Ann Arbor, Michigan 48105

NATIONAL POWER PLANT TEAM. 1976. 8-page brochure. Available from NPPT. A description of Team goals and capabilities. Team activities involve all aspects of power plant operations and sitings that might affect fish and wildlife resources.

FWS/OBS-76/20. TOPICAL BRIEFS: Fish and Wildlife Resources and Electric Power Generation.

A series of summaries on topics related to electric power generation and transmission and their effects on fish and wildlife resources. Each brief contains background information on and a discussion of the particular topic, a selected bibliography of additional information sources, and, in some cases, a strategy to address the problem.

FWS/OBS-76/20.1. IMPACTS OF POWER PLANT INTAKE VELOCITIES ON FISH. By John Boreman, National Power Plant Team. 1977. 10 pages. Available from NTIS as PB-266166. Price code: PC A02/MF A01.

An outline of biological problems associated with power plant intake velocities. This brief includes information needed to assess impacts of intake velocities on fishery resources and a list of technical references containing more detailed analyses of the problems and mitigation alternatives.

FWS/OBS-76/20.2. TRANSMISSION LINE RIGHTS-OF-WAY MANAGEMENT. By D. H. Arner, Mississippi State University. March 1977. 12 pages. Available from NTIS as PB-266167. Price code: PC A02/MF A01.

A summary of some current transmission line rights-of-way management practices and their costs, the bases for selecting a specific management technique, and some possible management goals to benefit fish and wildlife in various local situations.

FWS/OBS-76/23. GREAT LAKES FISH EGG AND LARVAE IDENTIFICATION. Edited by John Boreman, National Power Plant Team. 1976. 220 pages. Available from NTIS as PB-260772. Price code: PC A11/MF A01.

The proceedings of a workshop held April 19-21, 1976, in Ann Arbor, Michigan, to (1) assess the state-of-the-art of Great Lakes fish egg and larvae identification and (2) develop a strategy for future taxonomic work in the Great Lake region. Included with the proceedings are an annotated bibliography of the literature relevant to descriptions of Great Lakes fish eggs and larvae, fish species lists for each of the Great Lakes, and family characteristics of the fish larvae.

FWS/OBS-76/35. POWER: A Computer System for Corridor Location. By Robert H. Giles, Jr., A. Blair Jones III, and Charles W. Smart, Virginia Polytechnic Institute and State University, Blacksburg. 1976. 30 pages. Available from NTIS as PB-261960. Price code: PC A03/MF A01.

Description of a computer-base technique for power line corridor selection. Environmental impact is heavily stressed in the system as well as other aspects of corridor location such as maintenance and cost to rate payers.

STEAM ELECTRIC POWER PLANT REVIEW MANUAL AND APPENDICES. By Division of Ecological Services, Fish and Wildlife Service, and METREK Division of the MITRE Corporation, McLean, Virginia. 1977. 2 Volumes. Limited distribution — Contact Division of Ecological Services, Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C. 20240.

A manual summarizing policy and procedural guidelines and pertinent reference materials applicable to the program of the Division of Ecological Services, U.S. Fish and Wildlife Service, relative to steam electric generating power plants. The manual is applicable to all nuclear power generation plants and to those activities and characteristics of transmission lines and fossil-fueled power generation plants that are subject to Federal regulation in matters relating to the environment.

COASTAL ECOSYSTEMS

For information contact:

Information Transfer Specialist
National Coastal Ecosystems Team (NCET)
U.S. Fish and Wildlife Service
National Space Technology Laboratories
NSTL Station, Mississippi 39529

NATIONAL COASTAL ECOSYSTEMS TEAM. 1976. 8-page brochure. Available from NCET.

A description of Team goals and capabilities. The Team is an ecological survey and research management center involved in coastal problems such as wetland destruction and recently accelerated energy development problems.

FWS/OBS-76/05. AN ASSESSMENT OF ESTUARINE AND NEARSHORE MARINE ENVIRONMENTS. Edited by M. P. Lynch, B. L. Laird, N. B. Theberge, and J. C. Jones, Virginia Institute of Marine Science, Gloucester Point. March 1976 (revised). 132 pages. Available from NTIS as PB-254853. Price code: PC A07/MF A01. Also available from OBS, Washington, D.C.

An evaluation of the impact of water uses and projected water demands upon the estuarine and nearshore marine environments of the United States. The evaluation includes a regional review of major estuarine and nearshore marine habitats, the economic value of the areas, the major problems impacting water and water resources, and the management approach of the States.

FWS/OBS-76/22. IMPACT OF MOSQUITO CONTROL PRACTICES: A Bibliography. By Gulf South Research Institute, Baton Rouge, Louisiana. April 1977. 97 pages. Available from NTIS as PB-268241. Price code: PC A06/MF A01. Also available from NCET.

An annotated bibliography with sections on insecticide studies and environmental controls.

LIVING COASTAL RESOURCES: A Coastal Zone Management Technical Assistance Document. By National Marine Fisheries Service and U.S. Fish and Wildlife Service for Office of Coastal Zone Management. July 1976. 34 pages. Will be available from NTIS.

Discussion of living resource concepts and subjects important in the development of State Coastal Management Programs. This report should be useful to Federal and State agencies and public and private interests, in their interpretations of the living coastal resources requirements of the Coastal Zone Management Act of 1972 and CZM Regulations.

BIBLIOGRAPHIC SEARCH CAPABILITIES OF THE NATIONAL COASTAL ECOSYSTEMS TEAM. By Harold Rienstra, National Coastal Ecosystems Team, March 1977. 27 pages. Available from NCET.

A comprehensive list of available bibliographic resources, a partial list of non-bibliographic data bases, a checklist for preparation of an information request, and an example of a computer search.

ESTUARINE PROCESSES: Volume I, Uses, Stresses and Adaptation to the Estuary (541 pages); Volume II, Circulation Sediments, and Transfer of Material in the Estuary (428 pages). Edited by Martin Wiley, Chesapeake Biological Laboratory, University of Maryland Center for Environmental and Estuarine Studies, Solomons. 1976. Published by Academic Press, 111 Fifth Avenue, New York, N.Y. 10003, for the Estuarine Research Foundation. Available from Academic Press.

A collection of papers presented at the Third International Estuarine Research Conference at Galveston, Texas, October 7-9, 1975. The conference was conducted by the Estuarine Research Foundation with support from eight Federal agencies, including the U.S. Fish and Wildlife Service.

The next six reports were prepared for the Office of Biological Services by the Coastal Wetlands Program of the California Department of Fish and Game, Sacramento, as

part of its "Coastal Wetlands Series." The reports summarize the historical use and the natural resources of coastal areas in California. The problems and conflicts of use that affect the resources are identified and recommendations are provided. Will be available from NTIS.

THE NATURAL RESOURCES OF CARPINTERIA MARSH: Their Status and Future. By Keith B. MacDonald, Marine Science Institute, University of California at Santa Barbara. April 1976. 69 pages + appendices.

THE COASTAL WETLANDS OF NORTHERN SANTA BARBARA COUNTY. By Clark R. Mahrdt, Thomas A. Oberbauer, John P. Rieger, and Joseph R. Verfaillie, Center for Regional Environmental Studies, San Diego State University. 1976. 99 pages + appendices.

THE NATURAL RESOURCES OF THE NIPOMO DUNES AND WETLANDS. By Kent A. Smith, Coastal Wetlands Program, California Department of Fish and Game, Sacramento. 1976. 106 pages + appendices.

THE NATURAL RESOURCES OF AGUA HEDIONDA LAGOON. By Jack Bradshaw, Environmental Studies Center, University of San Diego. 1976. 110 pages + appendices.

THE NATURAL RESOURCES OF MUGU LAGOON. By Keith B. MacDonald, Marine Science Institute, University of California at Santa Barbara. 1976. 119 pages + appendices.

THE NATURAL RESOURCES OF ANAHEIM BAY. By John W. Speth, Bruce M. Browning, and Kent A. Smith, Coastal Wetlands Program, California Department of Fish and Game, Sacramento. 1976. 103 pages + appendices.

TRANSPORT PROCESSES IN ESTUARIES: Recommendations for Research. By B. Kinsman, et al. Workshop conducted by Marine Sciences Research Center State University of New York, Stony Brook, November 10-14, 1976. April 1977. 21 pages. Available from OBS, Washington, D.C.

The results of a workshop on transports of water, salt, and fine-grained suspended sediments. The problems of physical transport processes in estuaries are identified and the most effective ways of attacking the problems are explored.

EASTERN ENERGY AND LAND USE

For information contact:

Eastern Energy and Land Use Group (EELUG)
U.S. Fish and Wildlife Service
Harpers Ferry Center, Brackett House
Harpers Ferry, West Virginia 25425

EASTERN ENERGY AND LAND USE GROUP. 1977. 6-page foldout brochure. Available from EELUG.

A description of the group's goals and activities.

BALANCING NATIONAL ENERGY NEEDS WITH ECOLOGICAL REQUIREMENTS: Eastern Energy and Land Use Task Force Report, Executive Summary. APRIL 1977. 34 pages. Available from NTIS as PB-268028. Price Code: PV A03/MF A01.

A summary of the findings to date of the Eastern Energy and Land Use Task Force formed in October 1975. The Task Force has analyzed on-going and anticipated energy and mineral developments in the eastern United States to determine the impact on fish, wildlife, and their habitat and recommend solutions.

WESTERN ENERGY AND LAND USE

For information contact:

Information Transfer Specialist
Western Energy and Land Use Team (WELUT)
U.S. Fish and Wildlife Service
Room 206, Federal Building
Fort Collins, Colorado 80521

GENERAL:

WESTERN ENERGY AND LAND USE TEAM (WELUT). 1976. 12-page foldout brochure. Available from WELUT.

A description of the Team's function and organization.

FWS/OBS-76/27. WORKSHOP ON ENVIRONMENTAL/ ECOLOGICAL MAPPING NEEDS OF THE U.S. FISH AND WILDLIFE SERVICE. August 31-September 2, 1976, Monterey, California. Sponsored by the Coal Project, Office of Biological Services. September 1975. 37 pages. Available from NTIS as PB-268396. Price code: PC A03/MF A01.

Summary of a workshop aimed at developing mapping adequacy by the Fish and Wildlife Service in their future endeavors.

FWS/OBS-76/37. GUIDE FOR LINE TRANSECT SAMPLING OF BIOLOGICAL POPULATIONS. By Utah Cooperative Wildlife Research Unit, U.S. Fish and Wildlife Service, Utah State University, Logan. 1976. 28 pages. Available from NTIS as PB-268031. Price code: PC A03/MF A01.

Guidelines for the design and conduct of field surveys to estimate size or density of biological populations via a line transect sampling frame.

FWS/OBS-77/04. ENERGY, PUBLIC CHOICES AND ENVIRONMENTAL DATA NEEDS. By Frank M. Graves, et al., Institute of Public Administration and National Wildlife Federation, Washington, D.C. In press. 61 pages. Will be available from NTIS.

Description of energy-related decision processes of BLM, USGS, USFS, ERDA, Bureau of Reclamation, Water Resources Council, and the States of Montana, New Mexico, Utah, Colorado, and Wyoming. Recommendations are made whereby the Fish and Wildlife Service can more effectively communicate wildlife information to decisionmakers.

FWS/OBS-77/05. GUIDE TO LAND COVER AND USE CLASSIFICATION SYSTEMS EMPLOYED BY WESTERN GOVERNMENTAL AGENCIES. By Scott L. Ellis, et al., Ecology Consultants, Inc., Fort Collins, Colorado. March 1977. 184 pages. Available from NTIS as PB-265173. Price code: PC A09/MF A01.

Survey and list of classification systems in use by State and Federal agencies in 18 Western States and Provinces of Alberta and Manitoba in Canada. System descriptions are divided into three sections: local, regional and multiregional, plus some Canadian systems. Each system summary

includes the title of the system, contact person, objectives, background, description, products and related systems.

FWS/OBS-77/10. DIRECTORY OF EXISTING NATURAL RESOURCE AGENCY MANUALS AND HANDBOOKS. Prepared by Thorne Ecological Institute, Boulder, Colorado. March 1977. 61 pages. Available from NTIS as PB-268006. Price code: PC A04/MF A01.

Directory locating handbooks and manuals relating to wildlife produced by State and Federal agencies which are not cited in libraries or information retrieval systems.

WELUT PROJECT SUMMARIES. Prepared by the Western Energy and Land Use Team. Limited distribution from WELUT.

Brief descriptions and status reports of WELUT projects.

INSTREAM FLOW AND WESTERN WATER ALLOCATION:

For information contact:

Cooperative Instream Flow Service Group (CIFSG)
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
Room 206, Federal Building
Fort Collins, Colorado 80521

COOPERATIVE INSTREAM FLOW SERVICE GROUP. 1976. 4 pages. Available from CIFSG.

Brochure describing the group's function and organization.

INSTREAM FLOW BRIEFS. Prepared by the Cooperative Instream Flow Service Group, Western Energy and Land Use Team. Available from CIFSG.

Issued occasionally, the briefs provide a forum and information source for practitioners, planners, and others with interests in instream flow assessment.

FWS/OBS-76/03. METHODOLOGIES FOR THE DETERMINATION OF STREAM RESOURCE FLOW REQUIREMENTS: An Assessment. Edited by C. B. Stalnaker and J. L. Arnette, Utah State University, Logan. April 1976. 199 pages. Available from NTIS as PB-253152. Price code: PC A10/MF A01.

A compilation of methodologies, emphasizing the approaches of agencies, institutions and individuals actually involved in or practicing stream-flow management in its various forms.

NOMENCLATURE FOR INSTREAM ASSESSMENTS. By J. L. Arnette, Western Water Allocation, Office of Biological Services. 1975. 7 pages. Part of publication FWS/OBS-76/03. Available from CIFSG.

A glossary to provide a standard terminology for use by workers in the area of stream flow evaluation.

FWS/OBS-76/04. FISH AND WILDLIFE IMPLICATIONS OF UPPER MISSOURI BASIN WATER ALLOCATION: A RESEARCH ASSESSMENT. By William B. Lord, Susan K. Tubbesing, and Craig Althen. Institute of Behavioral Sciences, University of Colorado, Boulder. 1975. 114 pages. Available from NTIS as PB-255294. Price code: PC A06/MF A01.

An assessment of major water allocation changes and their impact upon fish and wildlife in the area, including recommendations to mitigate potential problems.

FWS/OBS-76/10. A SELECTED ANNOTATED BIBLIOGRAPHY ON FISH AND WILDLIFE IMPLICATIONS OF MISSOURI BASIN WATER ALLOCATION. By Anita Cochran, Institute of Behavioral Science, University of Colorado, Boulder. 1975. 71 pages. Available from NTIS as PB-255295. Price code: PC A04/MF A01.

A bibliography containing information to be used in the context of making decisions on water allocation within the Upper Missouri River Basin with special focus upon the fish and wildlife implications of these decisions.

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. By W. Nelson, et al., Enviro Control, Inc., Rockville, Maryland. August 1976. 19 pages. Available from CIFSG.

Findings, conclusions and recommendations regarding changed flow regimes below dams, impact on fisheries and methodologies used to assess flow requirements for 96 dams and diversions in the Rocky Mountains and Pacific Northwest regions.

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. By W. Nelson, et al., Enviro Control, Inc., Rockville, Maryland. August 1976. 128 pages. Available from NTIS as PB-263470. Price code: PC A07/MF A01.

Analysis, findings, conclusions and recommendations regarding changed flow regimes below dams, impact on fisheries and methodologies used to assess flow requirements for 96 dams and diversions in the Rocky Mountain and Pacific Northwest Regions.

FWS/OBS-76/30. ASSESSMENT OF EFFECTS OF ALTERED STREAM FLOW CHARACTERISTICS ON FISH AND WILDLIFE, PART A — ROCKY MOUNTAIN AND PACIFIC NORTHWEST, ROCKY MOUNTAIN REGION CASE STUDIES. By W. Nelson, et al., Enviro Control, Inc., Rockville, Maryland. August 1976. 371 pages. Available from NTIS as PB-263471. Price code: PC A16/MF A01.

Individual analysis of changed flow regimes below dams, impact on fisheries and methodologies used to assess flow requirements for 49 dams and diversions in the Rocky Mountain Region.

FWS/OBS-76/31. ASSESSMENT OF EFFECTS OF ALTERED STREAM FLOW CHARACTERISTICS ON FISH AND WILDLIFE, PART A — ROCKY MOUNTAIN AND PACIFIC NORTHWEST, PACIFIC NORTHWEST REGION CASE STUDIES. By D. Wagaman, et al., Enviro Control, Inc., Rockville, Maryland. August 1976. 404 pages. Available from NTIS as PB-263472. Price code: PC A18/MF A01.

Individual analysis of changed flow regimes below dams, impact on fisheries and methodologies used to assess flow requirements for 47 dams and diversions in the Pacific Northwest Region.

FWS/OBS-76/32. ASSESSMENT OF EFFECTS OF ALTERED STREAM FLOW CHARACTERISTICS ON FISH AND WILDLIFE, PART B — CALIFORNIA, EXECUTIVE SUMMARY. By Charles Hazel, Jones and Stokes Associates, Inc., Sacramento, California. December 1976. 20 pages. Available from CIFSG.

Findings, conclusions and recommendations regarding changed flow regimes below dams, impact on fisheries, and methodologies used to assess flow requirements for 46 dams and diversions in California.

FWS/OBS-76/33. ASSESSMENT OF EFFECTS OF ALTERED STREAM FLOW CHARACTERISTICS ON FISH AND WILDLIFE, PART B — CALIFORNIA, FINAL REPORT. By Charles Hazel, Jones and Stokes Associates, Inc., Sacramento, California. December 1976. 65 pages. Available from NTIS as PB-263245. Price code: PC A04/MF A01.

Analysis, findings, conclusions and recommendations regarding changed flow regimes below dams, impact on fisheries, and methodologies used to assess flow requirements for 46 dams and diversions in California.

FWS/OBS-76/34. ASSESSMENT OF EFFECTS OF ALTERED STREAM FLOW CHARACTERISTICS ON FISH AND WILDLIFE, PART B — CALIFORNIA, CASE STUDIES. By Charles Hazel, et al., Jones and Stokes Associates, Inc., Sacramento, California. December 1976. 611 pages. Available from NTIS as PB-263246. Price code: PC A99/MF A01.

Individual analysis of changed flow regimes below dams, impact on fisheries and methodologies used to assess flow requirements for 46 dams and diversions in California.

FWS/OBS-77/19. GUIDELINES FOR PREPARING EXPERT TESTIMONY IN WATER MANAGEMENT DECISIONS RELATED TO INSTREAM FLOW ISSUES. Edited by Lee Lamb; produced by the Cooperative Instream Flow Service Group, Western Energy and Land Use Team. In press. 42 pages. Will be available from NTIS as PB-268597. Price code: PC A03/MF A01.

Document giving practical guidance to field biologists and other professionals regarding what to expect when they become directly involved in some form of litigation and are asked to present the results of their research or investigation.

PROCEEDINGS OF THE SYMPOSIUM AND SPECIALITY CONFERENCE ON INSTREAM FLOW NEEDS. Presented by the Western Division of the American Fisheries Society and the Power Division of the American Society of Civil Engineers, Boise, Idaho. September 1976. 2 Volumes, 1208 pages. Available for \$20 from the American Fisheries Society, 5410 Grosvenor Lane, Bethesda, Maryland 20014.

Proceedings discussing solutions to technical, legal, and social problems caused by increasing competition for limited streamflow.

COAL:

For copies of the following reports contact:

Information Transfer Coordinator
Office of Biological Services
U.S. Fish and Wildlife Service
Washington, D.C. 20240

FWS/OBS-76/17. COAL PROJECT: FIVE YEAR FRAMEWORK (FY 1976 THROUGH FY 1980). Office of Biological Services, Washington, D.C. July 1976. 44 pages. Available from OBS, Washington, D.C.

A document presenting the total scope of the framework for the Coal Project over the next 5 years. The project's purpose is to provide the expertise and necessary information to allow for effective involvement of the Fish and Wildlife Service in coal development actions, nationally.

FWS/OBS-76/18. COAL PROJECT: BACKGROUND INFORMATION (PLANNING AND MANAGEMENT). Office of Biological Services, Washington, D.C. July 1976. 49 pages. Available from OBS, Washington, D.C.

Summary information on coal development in the United States, and material on the potential interactions of that development with fish and wildlife resources. Coverage is provided on the recently initiated Federal Coal Leasing Program and a discussion on biogeographic considerations.

FWS/OBS-76/19. COAL PROJECT: EXECUTIVE SUMMARY (COAL PROJECT FIVE YEAR FRAMEWORK). Office of Biological Services, Washington, D.C. July 1976, 8 pages. Available from NTIS as PB-267962. Price code: PC A02/MF A01.

An overview of the entire Coal Project.

FWS/OBS-77/09. THE ECOLOGICAL EFFECTS OF COAL STRIP MINING: A Bibliography with Abstracts. By Sally Ralston, et al., Natural Resource Ecology Laboratory, Fort Collins, Colorado. March 1977. 416 pages. Available from NTIS as PB-265316. Price code: PC A18/MF A01.

Bibliography contains references with abstracts, on ecological effects of coal strip-mining in western United States, with emphasis on Northern Great Plains. There are two parts to this bibliography; Part I contains the references and abstracts, Part II is an extensive "key work in title" index to the references.

AN ECOSYSTEM PARADIGM FOR ECOLOGY. Edited by Philip L. Johnson, Oak Ridge Associated Universities, Oak Ridge, Tennessee. April 1977. 20 pages. Available from OBS, Washington, D.C.

The results of a workshop organized by Oak Ridge Associated Universities and The Institute of Ecology. Collective views of the participants are presented on the nature of ecosystem ecology as a science. The workshop was supported by the Rockefeller Foundation and the Office of Biological Services, U.S. Fish and Wildlife Service.

GEOHERMAL MINERAL, AND OIL SHALE:

FWS/OBS-76/01. WILDLIFE AND OIL SHALE: A PROBLEM ANALYSIS AND RESEARCH PROGRAM. 2 Volumes; Volume 2 — Appendix and Bibliography. Coordinated by Hubert D. Burke, Thorne Ecological Institute, Boulder, Colorado. September 1975. Available from NTIS as PB-250521 (Volume 1) and PB-250522 (Volume 2). Price code: PC A07/MF A01.

This report considers the nature and social environment of the Oil shale Region of northwestern Colorado, northeastern Utah, and southwestern Wyoming and evaluates the effects of an oil shale industry upon the environment. Recommendation for mitigation of undesirable changes are given.

FWS/OBS-76/36. GEOTHERMAL PROJECT, 1976. By Jones and Stokes Associates, Inc., Sacramento, California. June 1976. 194 pages. Available from NTIS as NP-21172. Price code: PC A09/MF A01.

A handbook to serve as a working tool in the field. Includes future geothermal resource development locations, a set of environmental assessment procedures, and mitigation and possible enhancement techniques.

FWS/OBS-77/20. FEDERAL FEASIBLE AND LOCATABLE MINERAL REGULATIONS: An Environmental Guide for Resource Analysis. By R. Moore, Ecology Consultants, Inc., Fort Collins, Colorado. In press. 97 pages. Will be available from NTIS.

A compilation of flow diagrams and associated narrative addressing the legal and administrative framework governing Federal land and mineral-leasing procedures.

STREAM ALTERATIONS

For information contact:

Information Transfer Specialist
National Stream Alterations Team (NSAT)
U.S. Fish and Wildlife Service
Route 1
Columbia, Missouri 65201

NATIONAL STREAM ALTERATIONS TEAM. August 1976. 8-page brochure. Available from NSAT.

A description of Team goals and capabilities. The Team has responsibility for dealing with impacts of resource development on aquatic and riparian habitats.

FWS/OBS-76/06. EVALUATION OF CHANNELIZATION AND MITIGATION OF THE FISHERY RESOURCES OF THE ST. REGIS RIVER, MONTANA. By John A. Lund, Cooperative Fishery Research Unit, U.S. Fish and Wildlife Service, Montana State University, Bozeman. June 1976. 49 pages. Available from NTIS as PB-257080. Price code: PC A04/MF A01.

FWS/OBS-76/07. CHANNELIZATION ASSESSMENT, WHITE RIVER, VERMONT: REMOTE SENSING, BENTHOS, AND WILDLIFE. By Wendell E. Dodge, Earl E. Possardt, Roger J. Reed, and William P. MacConnell, Massachusetts Cooperative Research Units, U.S. Fish and Wildlife Service, University of Massachusetts, Amherst. 1976. 73 pages, available from NTIS as PB-268247. Price code: PC A05/MF A01.

A collection and analysis of data on the amount of different types of fish and wildlife habitats along the White River; the amount and type of habitat altered in the 1973 flood disaster clean-up operation; and the effects of this habitat loss on fish, benthos, songbirds, amphibians, mammals and reptiles.

FWS/OBS-76/08. EFFECTS OF CHANNELIZATION OF THE LUXAPALILA RIVER ON FISH, AQUATIC INVERTEBRATES, WATER QUALITY, AND FURBEARERS. By Dale H. Arner, H. R. Robinette, John E. Frasier, and Marion H. Gray, Mississippi State University. June 1976. 59 pages. Available from NTIS as PB-264507. Price code: PC A04/MF A01.

An analysis of biological data collected from an old channelized segment, an unchannelized segment, and a newly channelized segment of the Luxapalila River in Mississippi and Alabama. Productivity of the old channelized segment of the river has not recovered to the levels exhibited in the unchannelized segment.

Project work for reports FWS/OBS-76/11-16 was conducted at the Iowa Cooperative Fishery Research Unit, U.S. Fish and Wildlife Service, Iowa State University, Ames.

FWS/OBS-76/11. A STUDY OF THE EFFECTS OF STREAM CHANNELIZATION AND BANK STABILIZATION ON WARM WATER SPORT FISH IN IOWA: Subproject No. 1. Inventory of Major Stream Alterations in Iowa. By Ross V. Bulkley. July 1975. 338 pages. Available from NTIS as PB-257427. Price code: PC A15/MF A01.

Aerial photographs and public records were used in this study to determine the amount of channelization of Iowa streams with drainage areas greater than 50 square miles. The extent of channelization was determined by measuring stream sinuosity. It is estimated that from 1,000 to 3,000 miles of streams have been lost in Iowa since settlers first arrived.

FWS/OBS-76/12. A STUDY OF THE EFFECTS OF STREAM CHANNELIZATION AND BANK STABILIZATION ON WARMWATER SPORT FISH IN IOWA: Subproject No. 2. A Study of the Impact of Selected Bank Stabilization Structures on Game Fish and Associated Organisms. By Arthur L. Bulkley. May 1975. 116 pages. Available from NTIS as PB-257428. Price code: PC A06/MF A01.

A study of four types of bank stabilization structures, installed mainly for highway protection, to determine their impact upon game fish habitat in Iowa streams.

FWS/OBS-76/13. A STUDY OF THE EFFECTS OF STREAM CHANNELIZATION AND BANK STABILIZATION ON WARM WATER SPORT FISH IN IOWA: Subproject No. 3. Organisms in Central Iowa Warm Water Streams. By Laurence Robert King and Kenneth D. Carlander. April 1976. 217 pages. Available from NTIS as PB-257078. Price code: PC A11/MF A01.

A study of six central Iowa streams to determine whether fish and fish food organisms were affected by short-reach channelization associated with bridge replacement in the last 15 years.

FWS/OBS-76/14. A STUDY OF THE EFFECTS OF STREAM CHANNELIZATION AND BANK STABILIZATION ON WARM WATER SPORT FISH IN IOWA: Subproject No. 4. The Effects of Long-Reach Channelization on Habitat and Invertebrate Drift in Some Iowa Streams. By David William Zimmer and Roger W. Bachmann. May 1976. 87 pages. Available from NTIS as PB-257079. Price code: PC A05/MF A01.

A study of the relationships between channel morphometry, habitat diversity, and invertebrate density in 11 natural and channelized stream segments of the upper Des Moines River Basin. The most obvious effect of channelization on stream habitat was a reduction in the diversity of water depth and current velocity.

FWS/OBS-76/15. A STUDY OF THE EFFECTS OF STREAM CHANNELIZATION AND BANK STABILIZATION ON WARM WATER SPORT FISH IN IOWA: Subproject No. 5. Effects of Long-Reach Stream Channelization on Distribution and Abundance of Fishes. By Bruce W. Menzel and Harland L. Fierstine. July 1976. 108 pages. Available from NTIS as PB-257429. Price code: PC A06/MF A01.

A study of the relationships between habitat characteristics and the distribution and abundance of fishes in 11 natural and channelized warm-water stream segments of the upper Des Moines River. Species diversity was generally greatest in unchannelized woodland stream segments.

FWS/OBS-76/16. WARM WATER STREAM ALTERATION IN IOWA: Extent, Effects on Habitat, Fish and Fish Food, and Evaluation of Stream Improvement Structures (Summary Report). By R. V. Bulkley, et al., July 1976. 39 pages. Available from NTIS as PB-257426. Price code: PC A03/MF A01.

A summary of the results in five other subproject reports. Studies were conducted from 1973 to 1976 to determine the extent of stream channelization in Iowa, differences in

populations of fish and fishfood organisms in channelized and unchannelized streams, effects of stream alterations for highway bridge construction, and the value of stream-bank stabilization structures to fish habitat.

FWS/OBS-76/21. PRELIMINARY REPORT: GRAVEL REMOVAL STUDIES IN SELECTED ARCTIC AND SUBARCTIC STREAMS IN ALASKA. By Woodward-Clyde Consultants, San Francisco, California. December 1976. 127 pages. Will be available from NTIS.

An evaluation of the effects of gravel removal in streams. Guidelines are included to assist resource managers formulate recommendations to minimize environmental impact from operations involving the removal of gravel from streams and floodplains.

FWS/OBS-76/24. EFFECTS OF STREAM CHANNELIZATION ON FISH POPULATIONS IN THE BUENA VISTA MARSH, PORTAGE COUNTY, WISCONSIN. By Michael R. Headrick, Cooperative Fishery Research Unit, U.S. Fish and Wildlife Service, University of Wisconsin-Stevens Point. September 1976. 38 pages. Available from NTIS as PB-265243. Price code: A03/MF A01.

This study was part of an investigation of channelization impacts on fishery, aquatic invertebrate, and wildlife resources in the central Wisconsin sand plain. Recently dredged ditches were investigated to determine immediate effects; old ditches were investigated to determine how well fish populations had recovered 52-62 years after dredging.

FWS/OBS-76/25. EFFECTS OF STREAM CHANNELIZATION ON TERRESTRIAL WILDLIFE AND THEIR HABITATS IN BUENA VISTA MARSH, WISCONSIN. By Dwain M. Prellwitz, Cooperative Fishery Research Unit, U.S. Fish and Wildlife Service, University of Wisconsin-Stevens Point. December 1976. 64 pages. Available from NTIS as PB-265231. Price code: PC A04/MF A01.

This study was part of an investigation of channelization impacts on fishery, aquatic invertebrate, and wildlife resources in the central Wisconsin sand plain. Stream channelization affected wildlife in the Buena Vista Marsh by draining wetlands, setting back plant succession and decreasing habitat diversity along stream banks.

FWS/OBS-77/06. WINTER WATER AVAILABILITY AND USE CONFLICTS AS RELATED TO FISH AND WILDLIFE IN ARCTIC ALASKA: A Synthesis of Information. By William J. Wilson, Eugene H. Buck, Gary F. Player, and Linda Dwight Dreyer, Arctic Environmental Information and Data Center, University of Alaska, Anchorage. 1977. 221 pages + appendix. Will be available from NTIS.

A consolidation of available information related to fish overwintering, wildlife use of unfrozen water during winter, and winter water conditions. This report describes development activities that require water in winter, summarizes existing regulations and agency responsibilities governing water use, and assesses current and future winter water conflicts between man and fish or wildlife.

PROCEEDINGS OF THE SYMPOSIUM ON STREAM CHANNEL MODIFICATION, HARRISONBURG, VIRGINIA, AUGUST 15-17, 1975. Edited by Raymond V. Corning, Robert F. Raleigh, Gerald D. Schuder, Sr., and Alice Wood. 1976. 172 pages. Available for \$2 from Secretary, Stream Channel Modification Symposium, Route 1, Box 312, Grottoes, Virginia 24441.

A collection of papers on the process of stream channelization in relation to environmental impacts.

NATIONAL WETLAND INVENTORY

For information contact:

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FWS/OBS-76/09. PROCEEDINGS OF THE NATIONAL WETLAND CLASSIFICATION AND INVENTORY WORKSHOP. Held at the University of Maryland, College Park, July 20-23, 1975. Edited by J. Henry Sather, Western Illinois University, Macomb. Workshop conducted by the Wildlife Management Institute. 1976. 248 pages + appendix, 110 pages. Microfiche available from NTIS as PB-258079. Price code: MF A01. Paper copies available from OBS, Washington, D.C.

A review of the current status of wetland work being conducted by various governmental and private agencies. The "Interim Classification of Wetlands and Aquatic Habitats of the United States" is appended to the proceedings and incorporates many suggestions that emanated from the workshop.

EXISTING STATE AND LOCAL WETLAND SURVEYS (1965-1975). Prepared by the National Wetland Inventory Project, Office of Biological Services, U.S. Fish and Wildlife Service, St. Petersburg, Florida. May 1976. Volume I, 63 maps approximately 54 x 54 inches each (the maps are in six sections by Fish and Wildlife Service Regions). Volume II, narrative, 453 pages. Limited distribution—contact OBS, Washington, D.C.

A compilation of information, in map and narrative form, on wetland inventories conducted by Federal, State and local governments, and private conservation groups since 1965.

INDEX OF SELECTED AERIAL PHOTOGRAPHY OF THE UNITED STATES. Prepared by the National Wetland Inventory Project, Office of Biological Services, U.S. Fish and Wildlife Service, St. Petersburg, Florida. May 1976. Seven volumes (by Fish and Wildlife Service Regions) of 72 maps. Limited distribution—contact OBS, Washington, D.C.

A compilation of information displayed on 1:750,000-scale maps showing the location and extent of recent aerial photography.

ECOREGION AND LAND SURFACE FORM MAPS. Prepared by the National Wetland Inventory Project, Office of Biological Services, U.S. Fish and Wildlife Service, St. Petersburg, Florida. June 1976. 468 maps. Limited distribution—contact OBS, Washington, D.C.

A series of 1:250,000-scale maps of the entire United States displaying ecoregions, physical subdivisions, and land surface form.

HABITAT CLASSIFICATION AND ANALYSIS

REMOTE SENSING APPLICATIONS FOR FISH AND WILDLIFE SERVICE. By Don H. Rodgers and Elisabeth Cummings, U.S. Fish and Wildlife Service. June 1976. 62 pages. Limited distribution—contact OBS, Washington, D.C.

A review of the use of remote sensing in fish and wildlife management. Selected references and information sources are included.

FWS/OBS-77/01. IMPROVING FISH AND WILDLIFE BENEFITS IN RANGE MANAGEMENT: Proceedings of a Seminar held in conjunction with the 41st North American Wildlife and Natural Resources Conference, March 20, 1976, Washington, D.C. Edited by Joseph E. Townsend, Office of Biological Services, and Robert J. Smith, Office of the Secretary, U.S. Department of the Interior. 118 pages. Will be available from OBS, Washington, D.C.

An examination of traditional range management practices and the resulting conflicts with wildlife needs. Suggested solutions are given for some specific range management problems. The proceedings consist of papers presented at the seminar, panel discussions, question and answer period transcripts, and conclusions reached by the participants.

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