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USER NEEDS ASSESSMENT FOR AN OPERATIONAL GEOGRAPHIC INFORMATION SYSTEM

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By

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ABSTRACT

This report documents the results of a five month survey of user needs for a geographic information system within Region Six of the U.S. Fish and Wildlife Service (FWS). This report culminates the first of seven project tasks being performed under contract to the U.S. Department of the Interior, U.S. Fish & Wildlife Service, Office of Biological Services, Western Energy and Land Use Team (WELUT).

This project is defined and sponsored by the Western Energy and Land Use Team to promote more effective consideration of fish and wildlife values and resources in the numerous state and federal decisions concerning the rapid development of western land, energy, mineral and water resources.

The goal of this two year project is to develop an operational capability within the Fish and Wildlife Service to accept, store, manipulate and display spatially related data for use in a variety of FWS wildlife resource impact projects.

This task focused on the assessment of three groups of users: (1) the Denver Region Six Offices of FWS, (2) the Billings Area Office within Region Six, and (3) Special Projects of the Office of Biological Services. Some twenty individual user offfices were interviewed with structured questionnaires and follow-up sessions to identify their legislative mandates, programs, tasks, work elements, and specific spatial data needs.

Seven logical groups of data emerge as those which are required by multiple users. These generic data bundles or data compilation modules include:

1) Habitat-Species Distribution

2) Stream Structural, Physical and Biological Survey Data

3) Economic, Demographic and Land Use Change

4) Seasonal Demand For and Utilization of Fish and Wildlife Resources

5) Geographically Referenced FWS Land Ownership and Lease Data

6) Regional Mineral and Energy Related Activity Pattern Data

7) Ownership and Management Plans of Other Agencies

Individual user groups will require the results of each of these compilation modules to differ by 1) spatial resolution (from 2 1/2 acre polygons for site specific planning to 640 acre polygons for macro regional analysis), 2) data currency or updating frequency (from 3 month currency to 10 year currency), and 3) geographical coverage (from a 200 square mile site specific problem to a 85,000 square mile statewide analysis).

Representative users and cases can be selected from this broad user community. Working on selected test cases for these few users will demonstrate the solution of specific problems which can be applied to the more general group of users.

Task One (User Assessment Needs) resulted in four reports being produced, including this one (1.1), the other three reports are entitled:

Report 1.2 - A General Design Schema for an Operational Geographic Information System

Report 1.3 - User Needs Assessment Forms for an Operational Geographic Information System

Report 1.4 - Test Case Analysis for an Operational Geographic Information System

All four of these reports are available from OBS-WELUT. Reports 1.2, 1.3, and 1.4 are not necessary for an understanding of this Report 1.1.

ACRONYMS USED IN THIS REPORT

ADC	Animal Damage Control
BAO	Billings Area Office
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
CIR	Color Infrared
CMR	Charles M. Russell, National Wildlife Refuge
DCM	Data Compilation Module
EIS	Environmental Impact Statement
ES	Ecological Services
FRMS	Federation of Rocky Mountain States
FWS	U.S. Fish and Wildlife Service
GIS	Geographic Information System
HAG	Habitat Assessment Group
HEP	Habitat Evaluation Procedure
CIFSG	Cooperative Instream Flow Service Group
I&R	Interpretation and Recreation
NRMW	Northern Rocky Mountain Wolf
OBS	Office of Biological Services
USFS or FS	U.S. Forest Service
SCS	Soil Conservation Service
WELUT	Western Energy and Land Use Team
WIP	Wetland Inventory Project
WPA	Waterfoul Production Area

1.0 INTRODUCTION

1.1 Goal of Project

This project is defined and sponsored by the Western Energy and Land Use Team (WELUT) to promote more effective consideration of fish and wildlife resources in the numerous state and federal decisions concerning western land, energy, mineral and water resources.

The goal of this two year project is to develop an operational capability within the U.S. Fish and Wildlife Service (FWS) to accept, store, manipulate and output spatially related data for use in a variety of FWS programs. This includes not only the data that has been and will continue to be collected by the FWS, but also includes data available in computerized and non-computerized data files of other federal and state natural resource management agencies. This goal is to be achieved with minimal development of new computer software and minimal hardware requirements. The project will start on a prototype basis within selected test case areas and will broaden to other applications.

The primary operational level users of this system in its developmental stages are in the Billings Area Office (BAO) of the U.S. Fish and Wildlife Service. The biologists in this office are faced with the weekly task of assessing the wildlife resource impacts of various land use changes. This project will attempt to develop simple, usable, practical tools for operational use at the regional and area office level.

This report culminates the first of seven project tasks. Other technical reports will be produced as the system development proceeds.

1.2 Scope of This Report

This project arises in a context where many state, federal and industrial bodies are developing computer-based data storage and analysis systems to aid in planning and decision making. A growing stream of data and agency plans are available via computerized mapping and data exchange. Further, a variety of computer data storage and analysis techniques - especially composite mapping systems - already exist from which a FWS system can be rapidly developed.

The Billings Area Office (BAO) is considered to be representative of Area Offices in Region 6 and is regarded as the principal focus of the User Needs Assessment for data at the operational level. It is the area office which will eventually provide most of the data inputs and applications and will be serviced by some type of regional center.

Another focus of the user needs assessment is the Western Energy and Land Use Team (WELUT) research programs. The trends and models of future habitat and other high level studies may be derived in part from the area office data base.

Section 1.0 of this report provides an overview of the entire project, its goals, and main milestones.

Section 2.0 presents the general philosophy, approach, and direction of this User Needs Assessment Task I.

Section 3.0 outlines the results of the User Needs Survey at the Billings Area Office. Ten potential user groups were identified and their spatial data handling needs described.

Section 4.0 outlines the results of the User Needs Assessment within the Denver Regional Office. Several operational offices, and two "one time" planning studies are assessed in this section.

Section 5.0 describes the mandates, staffing and major tasks of three OBS Special Project Offices.

Section 6.0 describes a set of common data needs identified by users interviewed. These common data needs are described as a series of "data compilation modules". The detailed needs of each user group is summarized in a set of associated tables.

1.3 The Remaining Tasks of the Project

It may be useful here to point ahead to the remaining tasks of this project. These tasks include:

Task II Survey, assess, and compare existing computer software systems and geographic data bases which are relevant to FWS determined needs. This may include federal, state, and private software and data bases.

Task III Develop an interim software system and test data base(s) covering the pilot test area(s). (WELUT Montana-Wyoming test area).

Task IV Benchmark test and evaluate the most promising geographic information system software as determined from Task II.

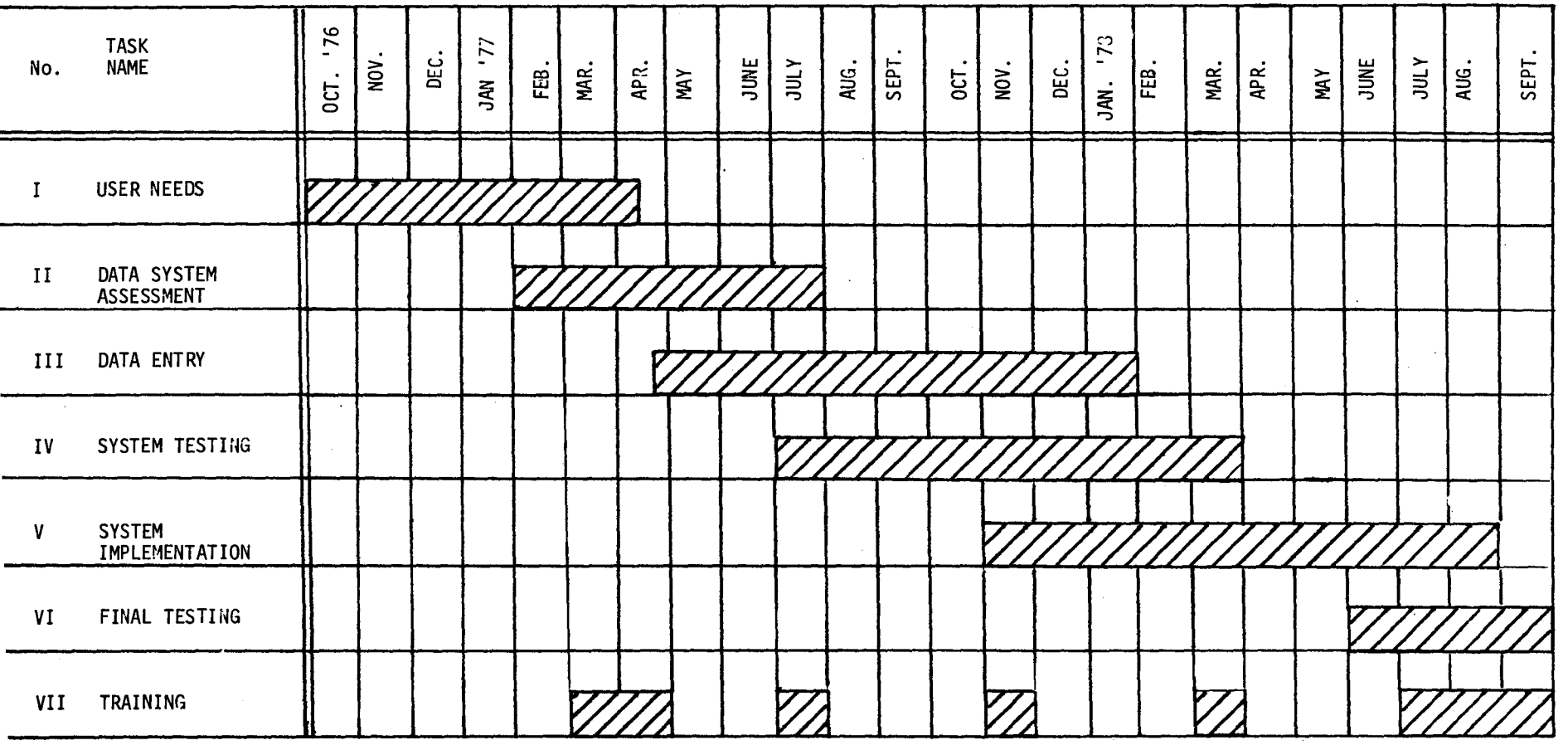
Task V Implement the selected software system on a government computer as determined by FWS-WELUT.

Task VI Test and debug the new FWS-WELUT geographic information system and document it with both users and technical manuals.

Task VII Train FWS personnel in the applications, use and limitations of the system. This task will be ongoing throughout the project.

Table 1.1 outlines a projected timetable of these tasks, some of which will run concurrently.

TABLE 1.1 WELUT - 02 PROJECT SCHEDULE



2.0 APPROACH TO INFORMATION SYSTEM USER NEEDS ASSESSMENT

2.1 Which Data, Analysis and Output Needs Should We Attack First?

User needs can be catalogued as data needs, analyses needs, and output needs. Each of these types of needs differs by user group. Figure #2.1 illustrates a hypothetical VENN diagram of overlapping "data" needs by users.

Section 3.9 of this report defines the data needs which are most central; i.e., those data elements which will satisfy the most users. Addressing these central data needs will both reduce data encoding costs per use and improve the quality of the data through more frequent updating. Simply stated, concentrating on common data needs gets "more information per dollar expended".

2.2 What Were the Objectives of the Assessment?

A User Needs Assessment is crucial to the success of this or any other geographic information system development. Many systems have failed due to neglect, user disinterest, or even sabotage simply because the target user community was not involved early or in a constructive fashion, in the design of the system.

A User Needs Assessment is important from several standpoints:

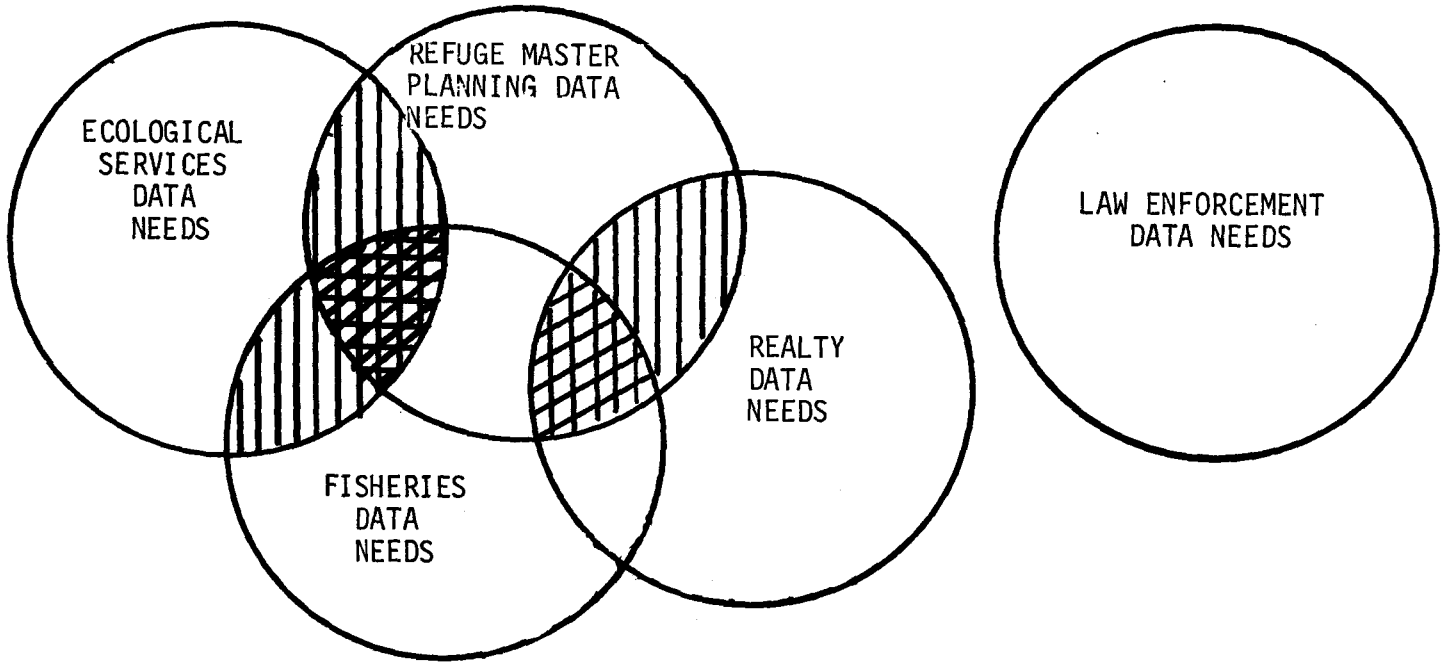
1) Without a User Needs Assessment, most systems are designed to maximize technical computer efficiency, rather than to satisfy the practical operational needs of the user community.

2) User involvement in the design process encourages better project communication. The mutual education of users and technicians will produce a better end product.

3) This specific project will require practical results to be produced in a short timeframe. These results must be understandable by operational personnel. Thus the system must be focused toward the immediate needs of operational personnel, which requires their early and heavy participation.

The User Needs Assessment task was outlined in the project proposal as a four month task which would set the stage for later system design and implementation. As the contractor team became involved with this task, the need for additional time to conduct a covering of all potential users of the system was required by the WELUT team. Due to the multiple research and operational interests in the project, the wide diversity of perceived users, and the evolving goals of the WELUT, it was decided that an additional two months effort above the amount initially allocated in the project scope of work and proposal should be spent on this task.

Figure 2.1 Schematic of Overlapping Data Needs of Programs



Data Needs of 3 groups

Data Needs of 2 groups

Data Needs of 1 group

The User Needs Assessment is nearing completion and it has been possible to accomplish the six following objectives:

1) To accurately identify the primary and secondary user(s) of the system 1/

2) To document the present mandates, the major programs, and data related tasks of each of these users within the Billings Area Office, the Denver Regional Office, the Office of Biological Services (OBS) and Special Project Offices;

3) To inventory and specify the spatially related data needs of the above user(s), and to highlight those data needs which are common to several different users;

4) To produce a document which would be available to a variety of readers who are interested in an overview of the activities of the Billings Area Office, the Denver Region Six Office, and the OBS Special Project Offices of the U.S. Fish and Wildlife Service;

5) To mutually educate the contractor and users as to the types of spatially related tools (e.g., map indexing procedures, automated library systems, composite computer mapping. etc.) which could be successfully applied to FWS problems, and

6) To involve the primary and secondary users in the early conceptualization phases of the system so that they will be knowledgeable and satisfied users after implementation.

2.3 What Procedure Was Used in the Needs Assessment?

The following steps were taken in the user needs assessment:

1) A list of prospective users was generated from early discussions with WELUT staff, previous FWS contacts, and the Region Six Directory;

2) Twenty groups of users (Ten Billings Area Office groups, six Denver Regional Office groups, and four OBS Special Project groups) were interviewed in a series of introductory meetings. (See table 2-1). These interviews were scheduled at the home office of the user to gain a general introduction to the responsibilities, programs, and staffing of each user group. Documents, espeiially Annual Work Plans were obtained from the user;

3) The contractor reviewed the documents and interview notes and summarized them in a series of forms #1, #2, and #3. Form #1 identifies the mandates, general programs, and staffing for each organizational element. Form #2 describes the work elements of each program. Form #3 describes the detailed spatial input needs, processes and outputs required for each work element. These

---

1/ This objective may seem trivial, however, many major system developments failed simply by imprecise identification of the primary user(s)

forms start with general programs and successively more toward greater detail. See Appendix A, B and C for copies of these forms (Report 1.3);

4) These forms were explained to, reviewed with and corrected by the various user groups in a second series of meetings;

5) These forms were edited, summarized and analyzed by the contractor for this report;

6) A summary seminar was held at the Billings Area Office during the week of March 7 - 11 to familiarize the users with the contractor's initial findings and to agree upon common data needs. Similar sessions were held with OBS Special Project staff and WELUT staff during the week of February 28 - March 4.

2.4 Why Does the Fish and Wildlife Service Need Their Own System?

The U.S. Fish and Wildlife Service is unique within the community of federal agencies in certain respects. FWS is now undergoing a "Technology Boom" a change in its interactions with other federal and state agencies and is moving toward a yet-to-be-defined set of new FWS policies. More particularly, the following four characteristics of FWS are relevant to this assessment:

1) FWS has a predominance of staff with training and professional experience exclusively in the areas of fisheries and wildlife biology. The influx of engineers, hydrologists, economists, land use planners, systems analysts, and other disciplines into FWS staff positions has been slow at the Regional Office level, and practically non-existent within the area and field offices.

2) FWS programs are highly dependent on biological-ecological relationships which are not yet fully understood by even the best researchers. This set of undefined relationships requires a system to be defined with many "black boxes" to be filled in later as the state of the art advances. Habitat suitability for fisheries is just one example of these "black boxes".

3) Except for the National Wildlife Refuge System, the FWS divisions have no direct land management responsibility. These FWS divisions advise other federal agencies (BLM, USFS, etc.) through a review process on any large scale development on federal lands which affects wildlife resource management. More effective ways of advising these land management agencies are now being explored at the field and regional level.

4) Except for the National Wildlife Refuge System, FWS has no area-wide goals and objectives, no established planning process, and consequently, FWS is continuously in a reactionary mode. Thus, every office takes an individual approach to wildlife resource management problems. Only recently have standardized procedures and other tools been introduced and these are not yet fully evolved or capable of being duplicated.

2.5 Involving Users in the System Design

Due to the above unique and dynamic characteristics of the FWS it is important for the system to grow with FWS. This requires close user involvement in the conceptualizing, designing and testing a system.

A cycle of user-technician involvement has proven successful in similar system development in other state and federal agencies. This cycle should include the following steps:

1) A long range user needs identification;

2) System conceptualization;

3) Design and implementation of a system using tests on familiar pilot areas;

4) Production of an intermediate product which can be reviewed by operational users;

5) Expand the system input and output capabilities;

6) Repeat the cycle from 3 through 5 as necessary;

Implementing this process will imply: (1) appointing key counterparts from the BAO to work with the technical team, (2) The counterparts will participate in the development of interim tests, (3) These counterparts may become involved as participants or speakers in FWS technical seminars in other area offices. The facilities of the new system can be featured in practical applications to their own work.

TABLE 2.1

PROSPECTIVE USERS INTERVIEWED

BILLINGS AREA OFFICE	
Burton W. Rounds	Area Manager
ECOLOGICAL SERVICES	
John G. (Gary) Wood	Supervisor, Ecological Services
Water Development Section	
Michael J. Erwin	Fish & Wildlife Biologist
Dennis M. Christopherson	Fish & Wildlife Biologist
Energy Section	
Lawrence L. Lockard	Fish & Wildlife Biologist
Section 10/404 Permit Section	
William E. Jones	Fish & Wildlife Biologist
LAND MANAGEMENT	
Robert Ballou	Assistant Area Manager for Refuges and Wildlife
Richard Johnson	Realty Officer
FISHERIES RESOURCES	
Jack D. Larmoyeaux	Assistant Area Manager for Fisheries
ANIMAL DAMAGE CONTROL & ENDANGERED SPECIES	
Norton R. Minor	Supervisor
COAL COORDINATORS	
Kent Keenlyne	Wyoming Coal Coordinator
Harold Tyus	Colorado Coal Coordinator
Dan Hinckley	Utah Coal Coordinator
LAW ENFORCEMENT	
Robert Freeman	Senior Resident Agent

TABLE 2.1

PROSPECTIVE USERS INTERVIEWED (CONT.)

DENVER REGIONAL OFFICE

ENVIRONMENT

ENVIRONMENT

John VanDerWalker	Assistant Regional Director
Office of Biological Services	
L. Rugles Porter	Senior Staff Biologist, Stream Alteration & Power Plant Siting
Land & Water Resources Development Planning	
Dale Sutherland	Senior Staff Biologist
Gene F. Forbes	Staff Biologist, Areawide Planning
REFUGES & WILDLIFE	
Paul Hartman	Staff Specialist, Wetlands Coordinator
Kent Olson	Senior Staff Biologist, Interpretation & Recreation
HATCHERIES & FISHERY RESOURCES	
Jack Dean	Staff Biologist
David I. Foster	Senior Staff Biologist
FEDERAL ASSISTANCE	
John Byrn	Staff Biologist, State Planning
REALTY	
Robert Young	Realty Officer

TABLE 2.1

PROSPECTIVE USERS INTERVIEWED (CONT.)

OBS SPECIAL OFFICES	
WELUT	
Dr. Harry Coulombe	Habitat Assessment, Group Leader
Dr. Clair Stalnaker	Instream Flow, Services Group Leader
Dr. Jack Gross	Ecological Modeling, Team Leader
NATIONAL WETLANDS INVENTORY	
Ross Pywell	Statistician

3.0 RESULTS OF THE USER NEEDS ASSESSMENT AT THE BILLINGS AREA OFFICE

3.1 Organizational Elements

Billings, Montana, is the location of one of the five area offices within Region Six of the U.S. Fish and Wildlife Service. The general responsibility of the Billings Area Office (BAO) is to carry out the mandates of the Fish and Wildlife Service (FWS) in Montana and Wyoming. To efficiently fulfill this responsibility, six organizational elements of FWS are represented in BAO, including: (1) Ecological Services; (2) Land Management; (3) Fisheries Resources; (4) Animal Damage Control; (5) Law Enforcement; and (6) Coal Coordination.

The following narrative provides a summary of an operational analysis of the programs and activities of these divisions. Information for the analysis was derived from a series of meetings held from November 1976 through February 1977. The detail of the operational analysis of each division was based on whether the divisional programs and activities use or produce spatial data. This criterion essentially determines the relevance of a division's activities to the capabilities of an automated geographic information system (GIS).

3.2 Ecological Services

Ecological Services (ES) employs an area supervisor and eight fish and wildlife biologists who have the general responsibility for assessing the effects of environmental change on the quality and quantity of fish and wildlife resources. The mandates for this responsibility are derived from several laws and policies including:

1. The Fish and Wildlife Coordination Act of 1958, requiring that the FWS be consulted on all federally authorized water resource development projects; and
2. Various "letters of understanding" between FWS and other federal agencies to involve FWS in their planning and environmental assessment procedures.

As a result of these mandates a number of programs have evolved in ES. These encompass (1) evaluating water development projects, especially reservoir construction projects sponsored by the Bureau of Reclamation and the Corps of Engineers; (2) analyzing water development projects requiring permits, leases, or federal licenses; (3) participating in areawide multiple use land and water planning; and (4) providing assistance in the assessment of the impacts of energy development

(especially coal) projects on fish and wildlife resources. Report 1.3 provides a more complete description of the mandates and staffing of the ES division.

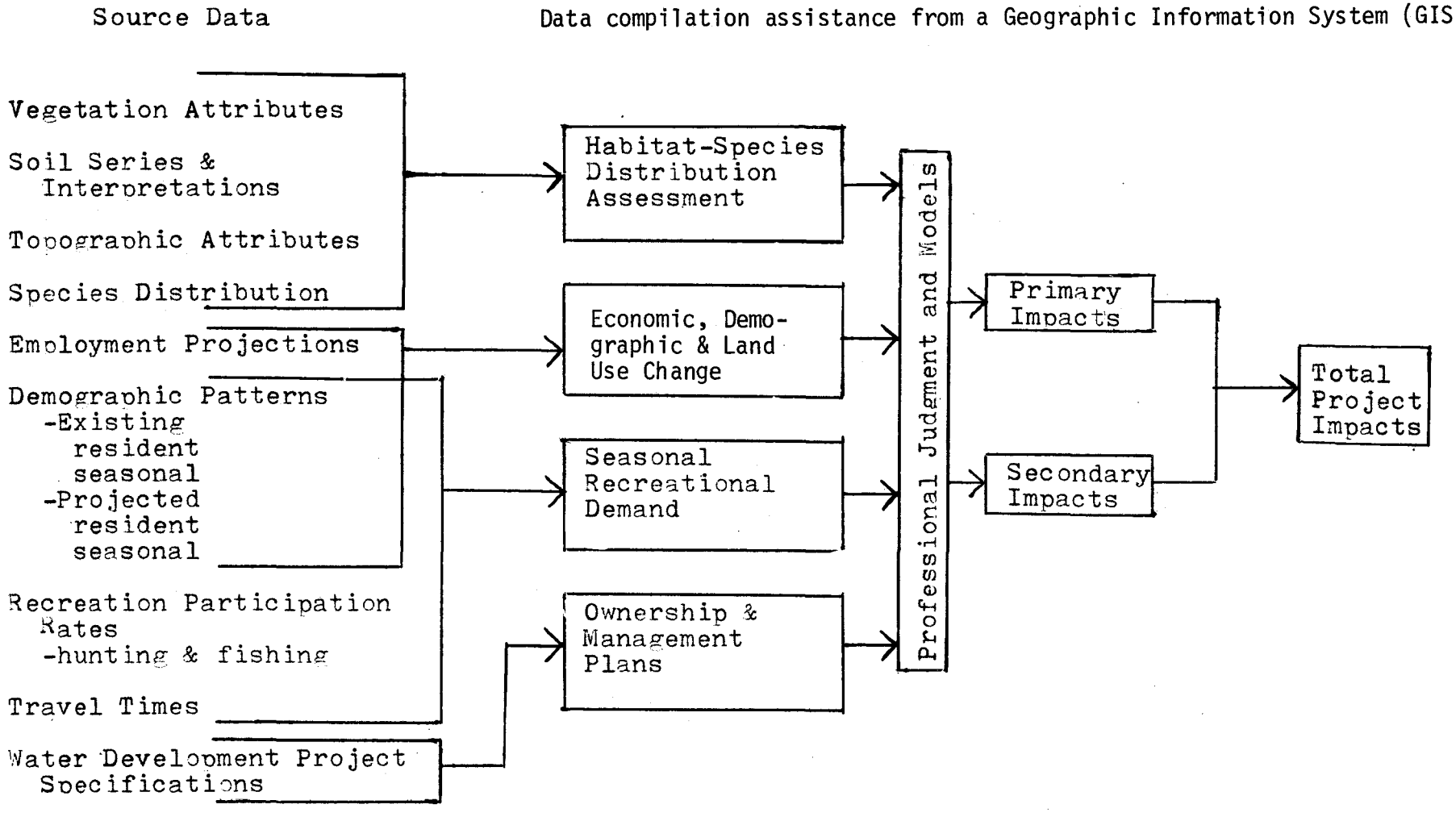
3.2.1 Water Development Projects Evaluation

Two or three times each year ES becomes involved in analyzing and reporting on the effects of major water and related land resource development projects on fish and wildlife resources and habitat. Basically, ES acts as fish and wildlife consultants to agencies such as the Corps of Engineers, Soil Conservation Service, Bureau of Reclamation, and other agencies sponsoring water resource development projects. The level of involvement in these projects is dictated by (1) the potential impacts of the project; (2) the amount of external (political) pressure to become involved; and (3) the availability of ES personnel to conduct the investigation.

In response to a number of laws and policies, and to gain a wider acceptance of a uniform wildlife habitat evaluation procedure, ES has developed a standard system of habitat evaluation. Known as the Habitat Evaluation Procedure (HEP), the system consists of monetary and non-monetary components for evaluating project impacts on fish and wildlife resources. In general, the non-monetary portion of HEP involves manually delineating a study area into vegetation types, assessing these types for their wildlife suitability, determining the immediate and long-term habitat losses resulting from the project, and determining the amount of compensation necessary to mitigate the habitat losses. The major components of the monetary portion of HEP included constructing supply and demand curves for each species and habatat type for all project alternatives. These curves are then used to compute the recreation man-days associated with the use of fish and wildlife resources and their corresponding dollar value. Report 1.3 provides a more detailed description of the components of HEP.

Presently, the non-monetary evaluation is widely used in BAO. Major inputs to the process include the delineation of vegetation types on 1:24,000 aerial photos, followed by field inspection to determine their suitability to sustain wildlife. These data are then employed to assess project impacts. However, present information and technical capabilities preclude an intensive assessment of secondary project impacts such as changes in land use and the proliferation of roads and other human development. Also, ES does not have the information or expertise to adequately complete the monetary portion of HEP. No major attempts have been made to organize or utilize demographic data, recreation demand data or recreation supply data. ES recongizes these as major deficiencies in their evaluation practices.

Figure 3.1 Ecological Services/Water Development Project Evaluations



Other criticisms of the existing habitat methodologies include:

1. The inability to rapidly reassess habitat losses when the development plans or alternatives are changed suddenly;
2. The large amount of time required to calculate acreages and perform other desk-top calculations; and
3. The lack of an efficient system to store and retrieve maps, aerial photographs, and data.

Figure 3.1 illustrates some of the possible relationships between HEP and an automated geographic information system with composite mapping capabilities. It should be emphasized that this system complements but does not supercede HEP, and requires professional judgment to select and weight variables to be composited. Report 1.3 defines the source data specified in Figure 3.1.

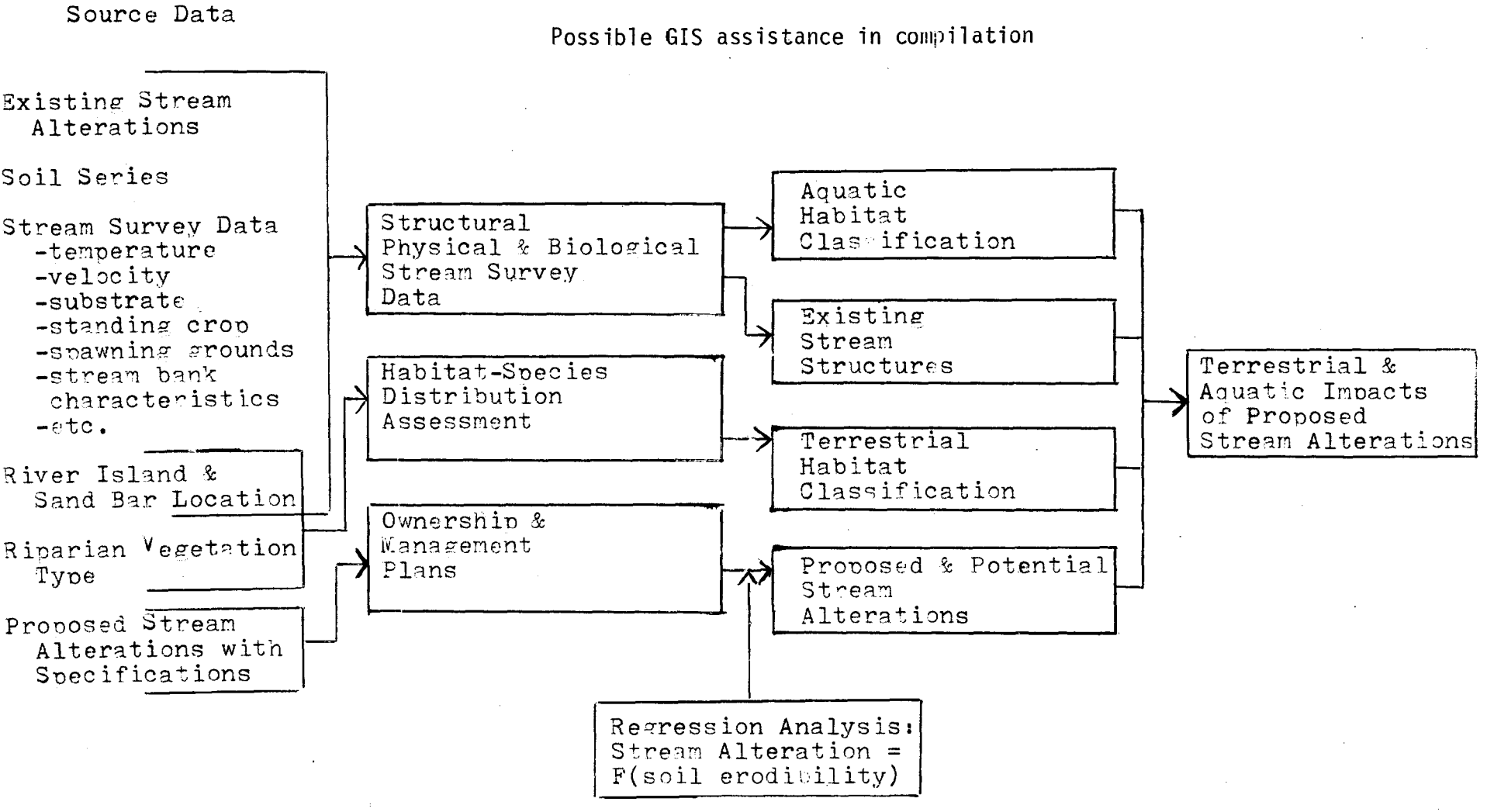
Many procedures studied in this Survey pointed to the need for automating certain data compilations, to arrive at composite maps of "land use" or "habitat" or other combinations of data and maps on soils, topography, vegetation, human population patterns, etc. Such procedures might be pre-compiled, i.e., into "data compilation modules" (DCM's). The user would simply need to define some controlling parameters (map topics, relative weights, etc.) and present the data to the DCM (which might already be stored in the system).

3.2.2 Permits and Licenses

Each year Ecological Services receives at least 100 requests to evaluate and report on the effects of stream alterations that require a federal permit or license. Major stream alterations, such as reservoir projects, are generally evaluated using HEP, but smaller alterations such as dredge and fill operations, riprap installation or dike construction occur so frequently, over such a large area, that detailed evaluations are often not feasible. Currently, evaluations range from on-site investigations of a proposed development to a routine in-the-office review of the specifications of the project to insure compliance with a set of standard criteria. Essentially, field evaluations include a qualitative assessment of the hydrologic and biologic consequences of a proposed development. Some of the factors considered include: river sinuousity, river flows, presence of islands, spawning grounds, riparian vegetation, and river substrate. Report 1.3 provides a more detailed description of the permit program and existing evaluation procedures.

ES recognizes that a number of deficiencies exist in its current approach to permit evaluation. A major deficiency is the lack of a system to keep track of all existing and proposed

Figure 3.2 Ecological Services/Permits and Licenses



stream alterations. In addition, existing stream survey data are not readily accessible to ES biologists to assist in the evaluation process. These deficiencies dictate that permit evaluations must be limited to what biologists are able to infer from project plans and/or on-site inspections.

Figure 3.2 illustrates some of the possible applications of an automatic geographic information system to permit evaluation. Essentially, this diagram illustrates a system for compositing stream alterations with the fisheries and wildlife attributes of the stream. Report 1.3 defines the characteristics of the source .

3.2.3 Areawide Planning

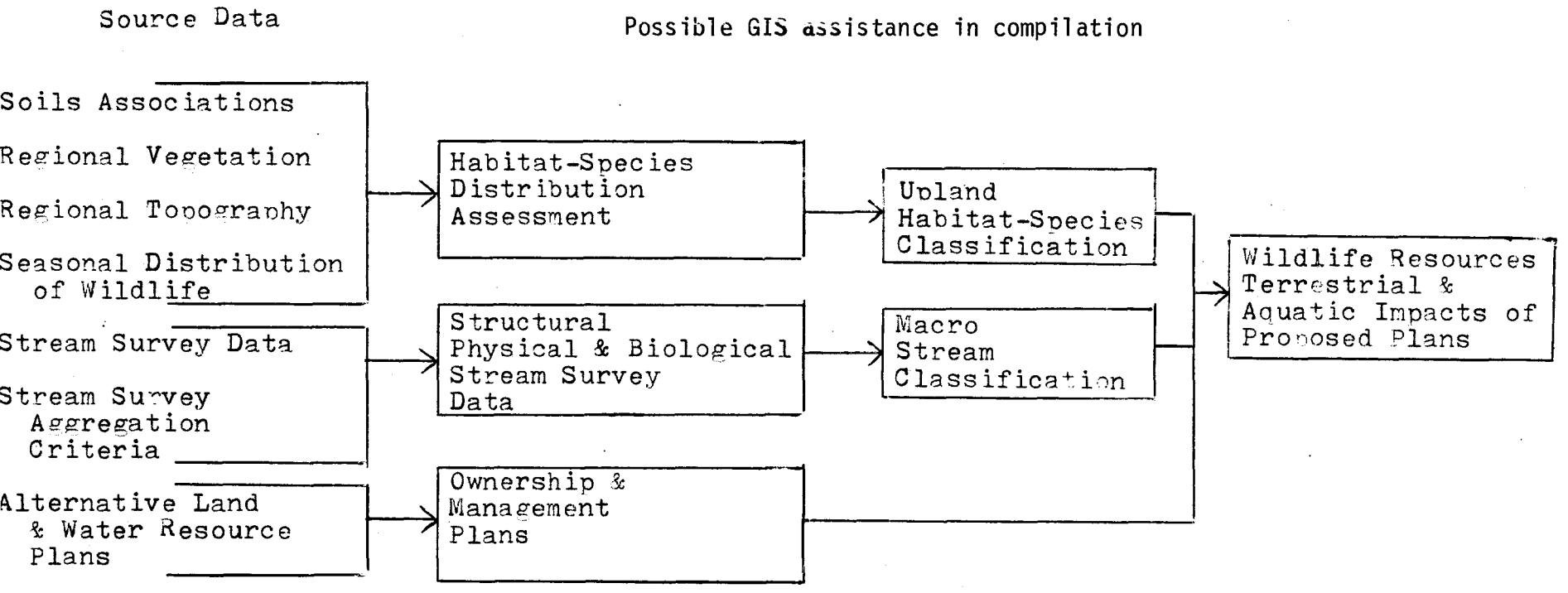
Areawide planning activities of ES are related to providing fish and wildlife input and review of land use and water development plans of the Water Resources Council, the Soil Conservation Service (SCS), the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS). The Water Resources Council and the SCS desire early involvement by FWS in their planning process; BLM and USFS generally request input and review of plan alternatives. However, according to the FY 1977 annual work plan, ES "would be well justified to become more actively engaged in such activities as land-use planning of the BLM and USFS, plus R,C,&D and Type 4 studies of SCS, but limited manpower, more direct mandates in other programs, and other circumstances continue to dictate a very low level of work. . . ."

Currently, ES's involvement in areawide planning is primarily centered around the Water Resource Council's Level B Study of the Yellowstone River Basin. However, even this involvement has diminished to a review role, due to a variety of political and interagency disagreements. In spite of the problems, ES feels that a systematic technique of assessing the impacts of these and other plans on fish and wildlife is needed to provide more credibility to its areawide planning involvement.

Areawide planning requires large amounts of data at a macro scale on: (1) land uses; (2) terrestrial and aquatic habitat resources; and (3) species distribution. By overlaying these data with land or water resource plans, impacts on fish and wildlife could be assessed. However, neither the data nor the compositing techniques are currently available to the Fish and Wildlife Service.

Figure 3.3 outlines the relationship between areawide planning data needs, several compilation modules, and composite mapping. Report 1.3 defines some of the characteristics of the source data .

Figure 3.3 Ecological Services/Areawide Planning



3.2.4 Energy Development Assessments

With the advent of mining activities in Montana and Wyoming, ES has received a mandate to assess the impacts of energy resource developments on fish and wildlife. Their principal involvement has come in the form of supplying a biologist from ES to serve on the interagency Northern Powder River Environmental Impact Statement (EIS) team. The objective of this 25-member interdisciplinary team is to develop a regional EIS and several site-specific EIS's for the proposed coal mining activities in the 8,000 square mile Powder River Basin of Montana.

Report 1.3 provides a detailed explanation of the fish and wildlife components to the Northern Powder River EIS. Essentially, wildlife habitat losses will be assessed by overlaying habitat maps and indicator species distribution maps with proposed energy developments. Fisheries habitat losses will be assessed by relating diminished water flows resulting from energy development activities to the minimum flow requirements essential to sustain populations of indicator fish species.

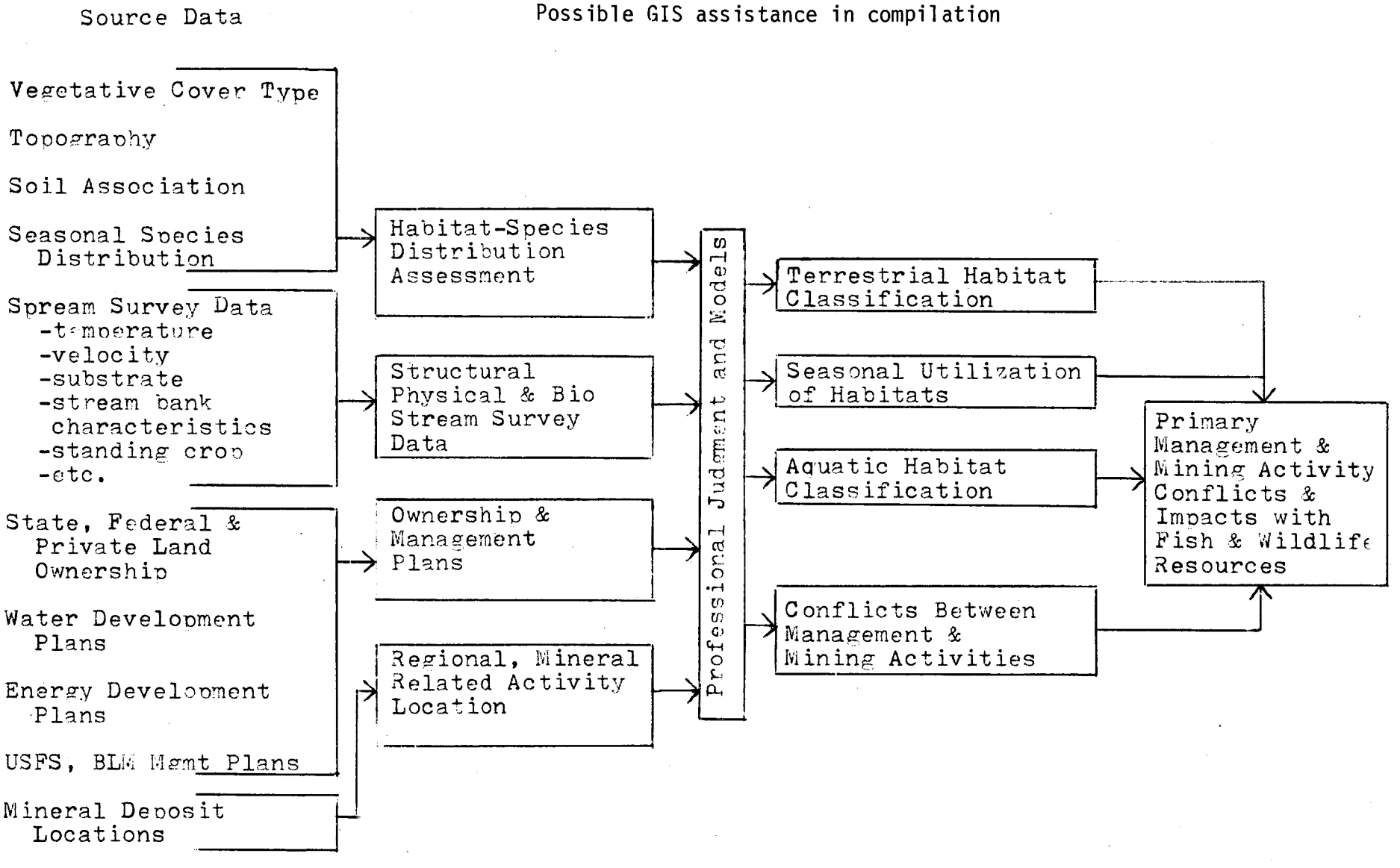
In the case of the Northern Powder River EIS team, data availability is not a problem; the state of Montana, BLM and USFS have compiled extensive fish and wildlife data bases for the study area. The principal problem appears to be the extensive area of study, the rapidly approaching deadline (March, 1978) for study completion, and the lack of any automated techniques to effectively deal with the volumes of data and maps.

Figure 3.4 illustrates how much of the fish and wildlife map data could be integrated with ownership and mining activity maps using an automated geographic information system with composite mapping capabilities. Report 1.3 supplies a detailed analysis of the source data .

3.3 Land Management

The Land Management Section of the Billings Area Office is the only group with responsibilities to acquire, plan for, and administer lands. These activities pertain to the eight staffed National Wildlife Refuges in Montana and Wyoming, and to the nearly 25,000 acres of Waterfowl Production Areas distributed throughout Montana. Sixty-five (65) refuge managers, biologists, other specialists, and non-professionals located throughout the two-state area utilize funds provided by the Migratory Bird program, the Mammal and Non-Migratory Bird Program, and the Interpretation and Recreation Program to manage these lands. A more detailed description of the mandates, programs, and staffing of the Land Management division is contained in Report 1.3.

Figure 3.4 Ecological Services/Energy Development



A wide variety of work elements are undertaken to accomplish this land management. These elements include:

1 Program and Site Master Planning for new or enlarged refuges and Waterfowl Production Areas (WPA).
2 Law Enforcement and Investigations on Refuges and WPA's.
3 Cropland Habitat Management.
4 Wetland Habitat Management.
5 Grassland Habitat Management.
6 Wildlife Population Management Practices.
7 Wildlife Management Surveys
8 Interpretation and Recreation (I&R) Facility Planning and Site Maintenance.
9 Waterfowl Production Area Easement Acquisition
10 WPA Fee Title Land Acquisition
11 Environmental Education on Refuges.

(See Report 1.3 for details on each of these projects.)

The Program and Site Master Planning of New or Enlarged Refuges (#1 above) was investigated more thoroughly for its specific data needs. These data needs are outlined Report 1.3 A geographic information system would be quite appropriate for use in this project due to the highly spatial nature of the problem and multiple data needs. A method of automating this refuge master planning process is outlined in the attached flowchart, Figure 3.5. Through a process of developing suitability maps for each of five sets of activities, (I&R activities, consumptive recreation, environmental education, wildlife production, and economic activities) and later overlaying these suitability maps, a set of activity conflict maps can be developed. By inter- and intra agency resolution of these conflicts, an overall master plan is obtained.

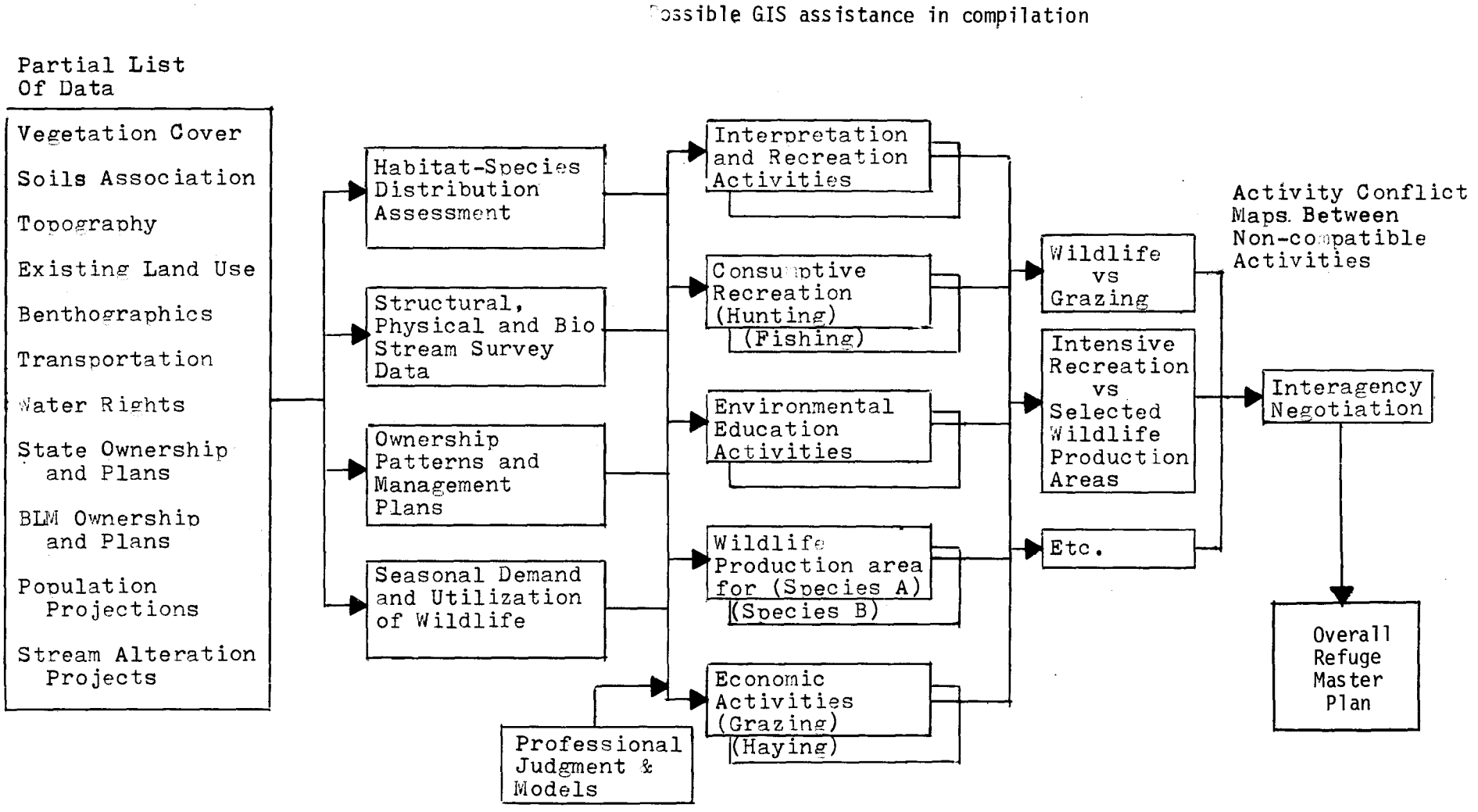
3.4 Fisheries Resources

The Fisheries Resources Division of BAO is responsible for two major operations: fish hatcheries and fish and wildlife technical assistance. The mandates for these programs are derived from several laws which give FWS the authority to: (1) establish fish hatcheries and propagate fish, and (2) assist and cooperate with agencies and organizations to manage, protect and stock fish and wildlife. These mandates are executed by an area supervisor, 29 fish hatchery personnel and 10 fish and wildlife biologists who provide technical assistance to requesting groups. (Report 1.3)

3.4.1 Fish Hatchery Operations

A variety of maintenance, fish production, fish distribution

Figure 3.5 Land Management Refuge Master Planning



and research activities are involved in the operation of five federal fish hatcheries in Montana and Wyoming. Report 1.3 summarizes the various components of these activities. In general, research consists of a variety of baseline studies aimed at improving hatchery production and fish distribution effectiveness. Day-to-day hatchery operations involve producing eggs, fry, and fish and distributing these products to federal, state, or Indian waters suitable for stocking.

Aside from the technical problems of raising fish and operating a complex facility, the major problems confronting fish hatchery operations are the lack of adequate funding and manpower to conduct all the existing or needed programs.

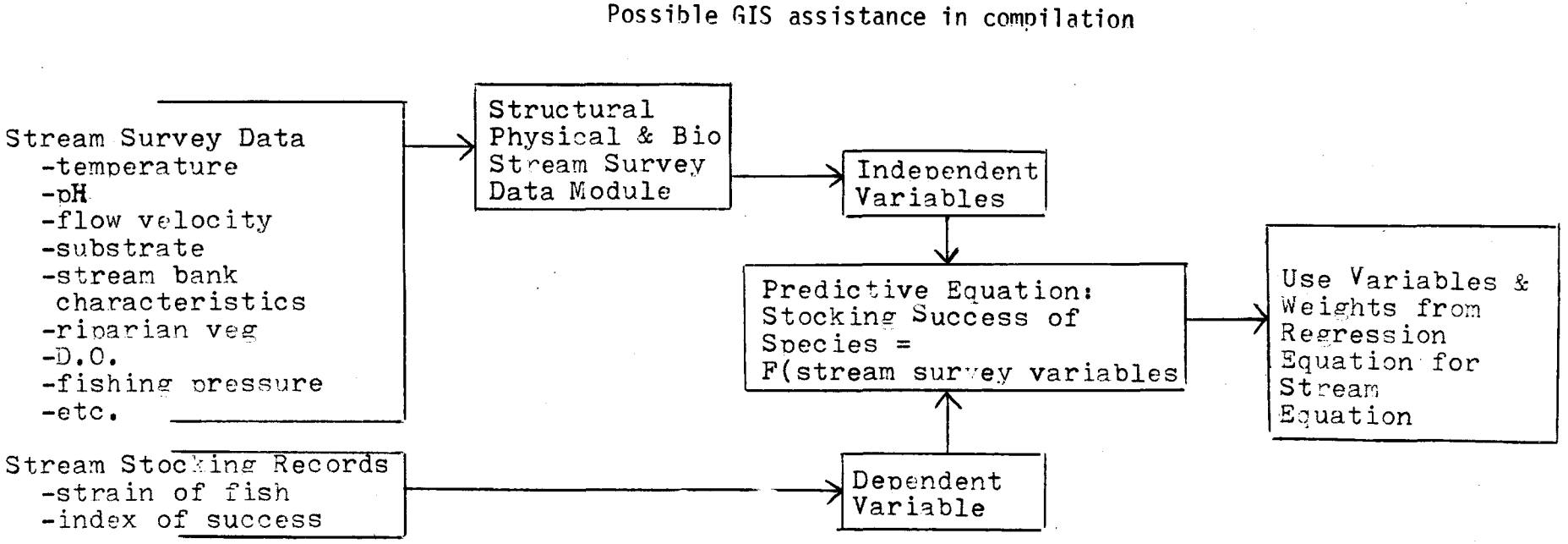
3.4.2 Fish and Wildlife Technical Assistance

The fisheries and wildlife technical assistance program provides agencies or individuals outside the Fish and Wildlife Service with technical expertise relating to fish and wildlife resource management programs. Within BAO the primary recipient of this service is the Bureau of Indian Affairs or local Indian reservations. Subsidiary beneficiaries include the National Park Service and the Department of Defense.

Fisheries technical assistance deals with a variety of fish husbandry and management activities including: hatchery design and operation, multiple land use management, harvest, and fisheries resource surveys, setting regulations, and training programs. Similarly, wildlife technical assistance programs involve: insuring that wildlife resources receive consideration under multiple use principles, gathering and analyzing a variety of data pertaining to wildlife populations and habitat, and setting regulations and seasons. A more detailed summary of these and other technical assistance activities is provided in Report 1.3.

A problem confronting fisheries technical assistants and state fish and game biologists is that of determining the correct strain of fish to use when stocking lakes and streams. Basically, the problem is that of identifying the factors that determine a successful stocking program. Figure 3.6 illustrates a possible application of the composite mapping and statistical analysis capabilities of an automated geographic information system to help determine optimum stocking strategies. Report 1.3 defines the characteristics of the source data.

Figure 3.6 Fisheries Resources/Technical Assistance



3.5 Animal Damage Control

The Animal Damage Control Division (ADC) is responsible for the animal damage control and the endangered species programs of the Fish and Wildlife Service in BAO. The principal mandates for these programs are the Animal Damage Control Act of 1931 and the Endangered Species Act of 1973. The ADC program is executed by an area supervisor, three field supervisors, and 16 to 22 trappers. The endangered species program is coordinated by the ADC area supervisor, who represents FWS on the Northern Rocky Mountain Wolf Recovery Team. Report 1.3 provides a more detailed description of the mandates and staffing of the Animal Damage Control Program and the Endangered Species Program, respectively.

3.5.1 Animal Damage Control Program

The direct control or removal of wildlife causing damage to livestock, public health or agricultural crops is the major activity in the ADC program. Mostly, this involves shooting or trapping coyotes that are causing damage to domestic sheep and cattle. The only other ADC program activity of any significance is a special survey conducted each fall to determine changes in predator abundance resulting from control efforts. Report 1.3 provides a more detailed description of the activities of the ADC program.

3.5.2 Endangered Species Program

The objective of the endangered species program is to remove endangered species from endangered status by re-establishing and maintaining viable populations in as much of their former range as possible. The Northern Rocky Mountain Wolf (NRMW) and the grizzly bear are the primary species being actively considered by the BAO under this program. Other endangered species are found in the area, but their recovery programs are being coordinated elsewhere. Currently, a major component of the program is the creation of an interagency team to develop an Endangered Species Recovery Plan for the NRMW. Report 1.3 provides more detail on the components of this plan.

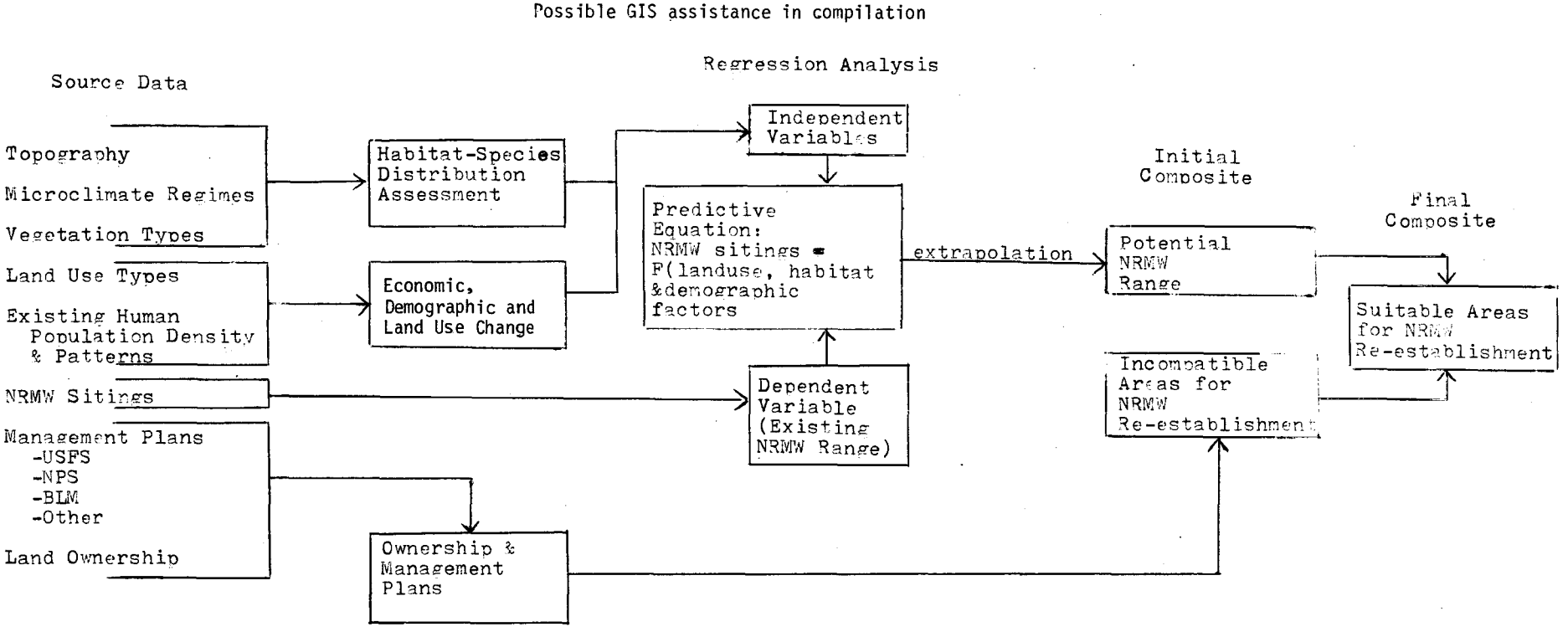
In a draft report on the NRMW Recovery Plan the team identified several important data information and methodological needs, including:

1. A standardized NRMW observation recording form;
2. A centralized storage, retrieval, and mapping system for NRMW observations;
3. Ownership, land use, and vegetation maps for the potential recovery area; and
4. Information on human densities, use patterns, and resource plans of other agencies.

Some of the desired outputs from the plan include the identification of:

1. potential recovery sites;
2. essential NRMW habitats; and

Figure 3.7 Animal Damage Control/Endangered Species Program



3. areas where the NRMW will not be allowed to live. Figure 3.7 shows how these needs could be addressed by an automated geographic information system with composite mapping and statistical analysis capabilities. Report 1.3 defines the source data variables. Report 1.3 defines the source data variables.

3.6 Law Enforcement

The Law Enforcement Division located in BAO is an arm of the Fish and Wildlife Service attached to the Regional Office. Their general responsibility is to enforce all federal laws and regulation governing fish and wildlife resources. Primarily, federal authorities encompass migratory birds, endangered species and the illegal transportation or shipment of wildlife. These authorities are derived from a variety of different acts, whose provisions are explicitly detailed in Title 50 of the Federal Code of Regulations (Report 1.3). In Montana and Wyoming, their enforcement is executed by a senior resident agent and three special agents.

3.6.1 Law Enforcement Division Activities

Investigation and enforcement account for approximately 85 percent of all the activities of the Law Enforcement Division. Basically, this involves all activities from routine patrols, to making arrests, to testifying in court. Other law enforcement work elements include: program planning, law enforcement training classes, permit administration, and wildlife-related import/export inspections. A summary of these and other law enforcement activities is contained in Report 1.3. Since few, if any, of the activities of the Law Enforcement Division use or produce spatial data, an extensive analysis of their problems and data needs was not undertaken.

3.7 OBS Coal Coordination Program

This newly organized OBS Program is aimed at establishing a communication between state, local, and industry offices and the Fish and Wildlife Service in the areas of coal and uranium impacts on communities. Both primary and secondary impacts are of interest in this program.

Four coordinators are employed within Denver Region 6; each is responsible for one or more states. The coal coordinators are: Kent Keenlyne, Wyoming; Dan Hinckley, Utah; Harold Tyus, Colorado; and Ray Hoem, Montana.
Refer to Report 1.3 for more detail.

Six interconnected projects are being undertaken by each of the four coal coordinators to varying degrees. These

projects include:

1. Coal Activity Status Determination, which involves the identification of the present and planned status of coal mining conversion and processing facilities. Critical points where FWS input can be effective will be identified.
2. Accelerated Coal Leasing Project is evaluating the relative terrestrial wildlife values of known coal lease areas in Wyoming. Each section is given a rating from 1 to 4 based on its wildlife value. This project has been contracted out to the Wyoming Game and Fish Commission to gain technical support and agreement between agencies.
3. The Coal Development Liaison Program is a prioritizing process for FWS contracts and internal projects.
4. Technical Assistance to Coal Development and Planning Activities is aimed at finding ways that FWS can meaningfully interact with USFS and BLM during the early stages of coal leasing and EIS review.
5. Developing Maps of High Impact Zones is a project aimed at spatially locating the areas where coal primary or secondary development will impact fish and wildlife resources.
6. Developing a Long Range FWS Master Plan for Coal and Uranium Development is a project which is specific to Wyoming and would be the logical extension of 5 above. It would try to minimize wildlife impacts throughout the state.

Refer to Report 1.3 for more detail on these projects.

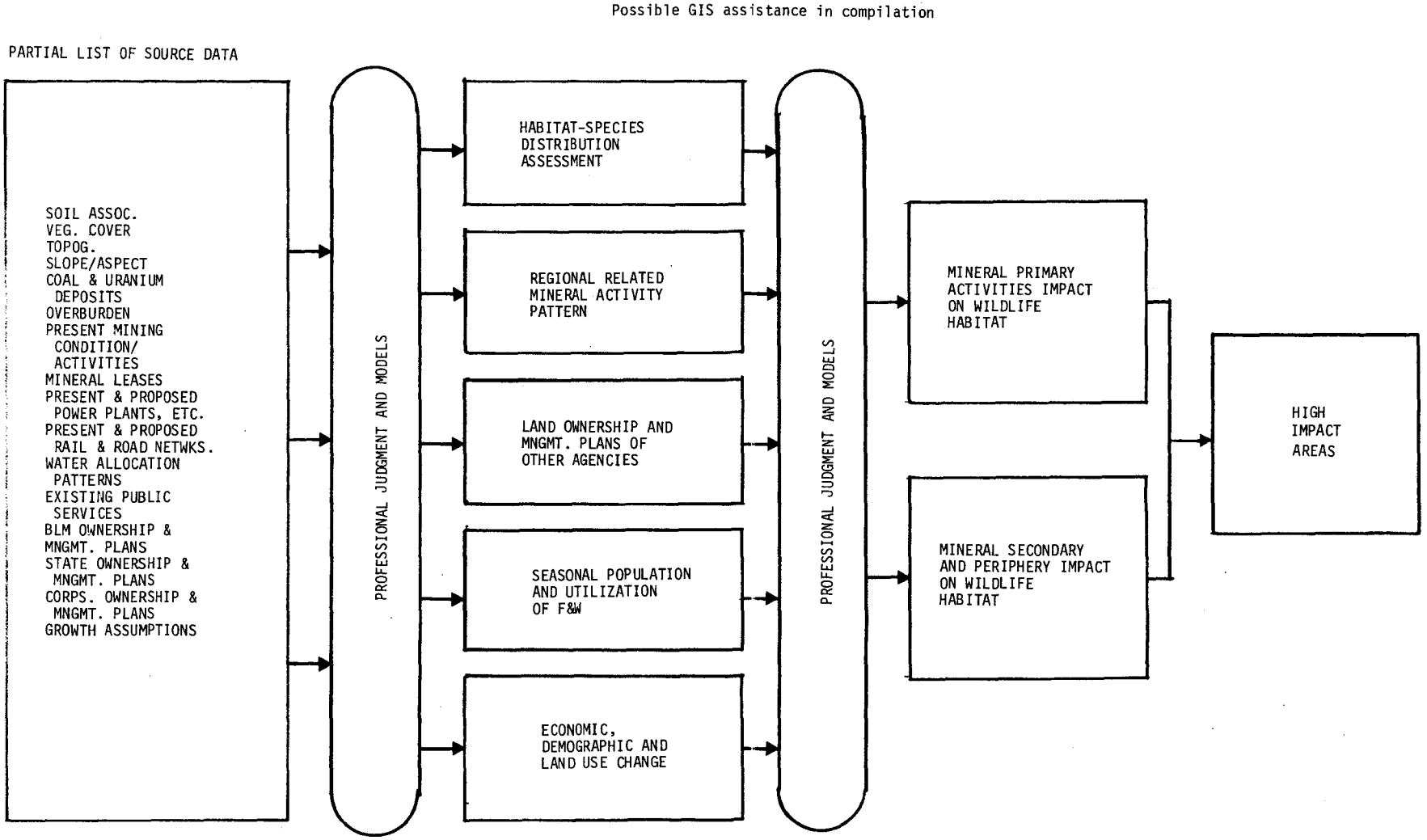
The project to determine high impact areas is one where the new tools of composite mapping could well be applied. Use of this methodology is outlined in Figure 3.8. This flowchart outlines the use of five data compilation modules (Habitat Assessment, Regional Mineral Activity Patterns, socio-Economic and Gross Land Use Changes, Land Ownership and Management Plans, and Seasonal Recreation Demand). These five modules would be combined to produce maps of primary and secondary impact areas. (See Report 1.3 for a more detailed outline of data needs for this project.)

3.8 Conclusions of the User Needs Assessment at the Billings Area Office

An examination of the Form 2's and Form 3's in Report 1.3 prepared for the BAO work elements reveals that there are some major differences between existing and desired programs. In the context of this project, this discrepancy is attributable to two factors:

1. The lack of a capability to effectively deal with the extensive amounts of data required to operate a viable program; and

Figure 3.8 Coal Coordination Impact Analysis



2. The lack of multi-disciplinary expertise to provide input to the non-biological aspects of a program.

These factors point to the need for a GIS that is user oriented; designed for users almost totally unfamiliar with computer science, systems analysis, and automated manipulation of data. In this regard, the GIS should be designed to address BAO's major problem of how to effectively compile and manipulate vast quantities of spatial data. The system should simultaneously train the BAO staff and provide answers to their basic data processing and analysis needs. To insure that the system becomes an operational component of BAO, precautions should be taken not to design a system so technical that its use would be restricted to highly computer-oriented users.

In summary, four divisions within BAO have a very immediate need for an automated geographic information system. These include: Ecological Services, Land Management, Animal Damage Control (endangered species), and Coal Coordination.

Almost all of the activities of ES use and produce extensive amounts of spatial data. Essentially, the effectiveness of water project, permit, energy, and areawide planning evaluations is determined by the effectiveness of the methodologies used to analyze and manipulate spatial information. Since current methods are completely manual, they are relatively ineffective at dealing with extensive data bases. Because of the heavy dependence on spatial data in all its activities, ES will be greatly benefited by an operational GIS.

Land Management has one overriding need for a GIS: to develop a master plan for the one-million-acre Charles M. Russell National Wildlife Refuge. The extensive area of CMR, the proven effectiveness of composite mapping to assist in master planning of other refuges[1], and the timing of the CMR planning effort all indicate the need for a GIS for CMR.

The recovery team for the endangered Northern Rocky Mountain Wolf is confronted with a task of developing a comprehensive recovery plan for a 20,000 square mile area of Montana and Wyoming. The extensive amounts of habitat, land use and demographic data necessary to develop this plan indicate a need for an automated data storage, mapping and analysis system.

Developing maps for coal coordination that locate where primary and secondary energy developments will impact fish and wildlife is an excellent opportunity to apply a GIS with composite mapping capabilities. Information afforded by these maps will be a first step toward the development of a viable energy planning process in FWS.

1. Robinette, A. and E. Crozier. 1976. Resource Planning: A Method for Allocating Land Uses in Natural Areas. USDI, Fish and Wildlife Service, Twin Cities, MN.

4.0 RESULTS OF USER NEEDS ASSESSMENT AT REGION SIX OFFICES

4.1 Introduction

This part of the user needs survey is concerned with the specific data needs of the offices in the Denver Region Six Offices.

Region Six of the U.S. Fish and Wildlife Service includes the states of Montana, Wyoming, Utah, Colorado, North Dakota, South Dakota, Nebraska, Kansas, Iowa, and Missouri. The Regional Office is located in the Denver Federal Center, Lakewood, Colorado.

To determine the potential needs and uses of a geographic information system at the Regional Office level, and initial regional contact list identifying present and future users of an automated information system was prepared. The contact list expanded during the interview period as additional users were suggested.

Two basic office processes were examined: 1) Annual work plans of divisions and 2) required data for on-going field programs. A structured questionnaire was prepared which provided a uniform method for categorizing programs, work elements, data input requirements, and data output characteristics. These survey questionnaire forms are attached in Report 1.3.

The major responsibilities of the Regional Office that could utilize a geographic information system include:

1) Record keeping concerning the acquisition of leasing of all FWS lands such as WPAs, game ranges and refuges;

2) Developing guidelines for the prepartion of comprehensive master plans for FWS refuges;

3) Determining where allocation of funds is most appropriate for such programs as: endangered species, fish hatchery research, fish fry distribution, and state game and fish programs, and;

4) Prototype study areas such as Yampa and Colorado Basin studies being conducted by Ecological Services.

4.2 Upper Colorado River Basin Project

The Upper Colorado River Basin Project is a study of long-term changes in land use, water use, wildlife habitat, and appropriate conservation policies for alternative futures. This is the most extensive and recent of the FWS programs dependent upon multiple data sources and interagency federal and state programs.

Before examining the Upper Colorado River Basin study needs, it is useful to check the characteristics of Level B planning, which influence the Upper Colorado River Basin study and help specify the tasks of an automated data system. These tasks are:

1) Regional economic resources, development potentials, basic and secondary employment and population must all be mapped and projected for long future periods - a complex problem in analysis, step-wise growth modeling, and analysis of impacts upon habitat;

2) Social and economic utilization of any FWS program should be analyzed for location of benefits, and associated costs, and;

3) Alternative FWS programs should be defined and evaluated under (b), with implied stages of development and utilization.

Figure 4.1 postualates a data flow which is believed to be characteristic of wide regional studies of alternative future development.

Regional information data flows include many elements of data (maps, tables). The elements are entered into the data file, and composited in various ways via data compilation modules. Subsequently, these modules are composited again into plans and policies.

As figure 4.1 indicates, automation and conversions of data to a common format make possible several powerful procedures from the analytic standpoint. The procedures that could be accomplished by a Geographic Information System (GIS) for a Colorado River Basin type study are:

1) Conversion of all incoming maps and remote sensing into uniform scales, grids and desired data legends;

2) Compilation of several data sources into intermediate modules such as habitat and species locations, and seasonal population distribution. These may involve several types of modeling or compositions;

3) Pyramiding of these intermediate solutions into alternative plans where several components may be changed to reflect different assumptions of location, growth, timing or environmental constraint.

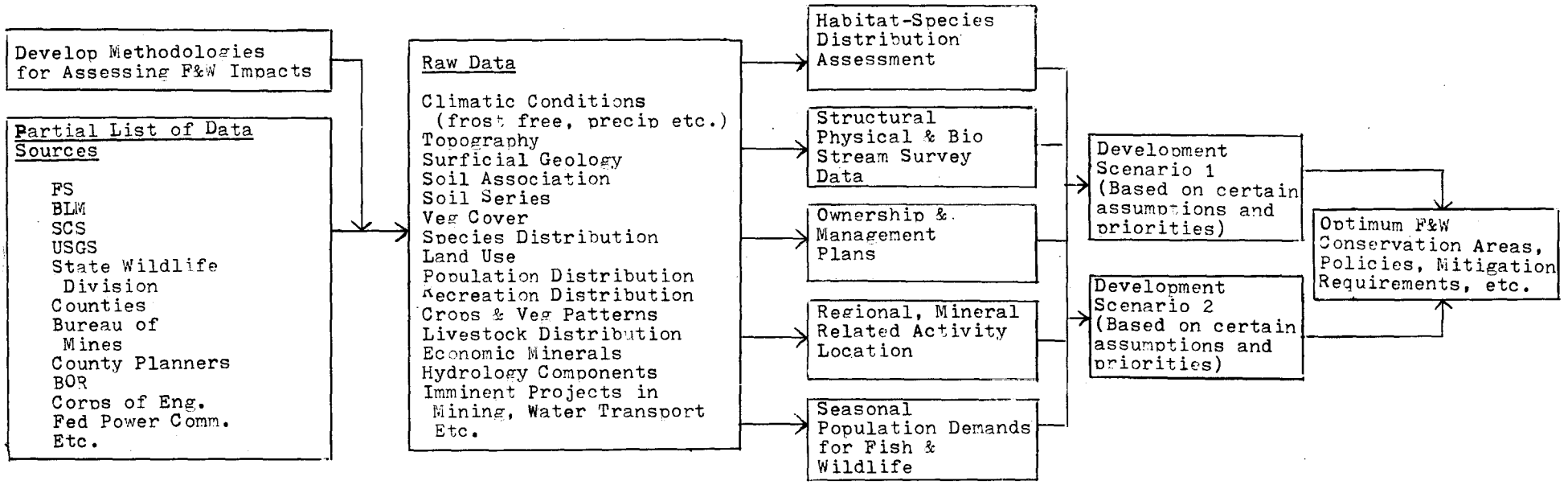
A more detailed description of programs and data needs of a Colorado Basin type study is in Report 1.3.

4.3 Yampa River Basin Project

Another indicative effort of regional planning, which will probably reoccur elsewhere, is the Yampa River Basin planning and policy study covering some 7,300 square miles of northwest Colorado. In addition to

Figure 4.1 Ecological Services/Colorado River Basin Project

Possible GIS assistance in compilation



This is a partial list of needed reference information which will occur in many forms, scales- maps, aerial photos, remote sensing social and economic data.

These second level compilations represent different relative weights or configurations of the intermediate modules. The biologist or administrator may prescribe the assumptions for these scenarios, and they will be coupled by the data processing assistant.

high quality fish and wildlife habitat the Basin also contains enormous reserves of energy minerals, coal, oil and gas, and sufficient water for various kinds of processing and energy production. All these development potentials are to be interpreted for impacts upon fish and wildlife habitat and utilization, and appropriate conservation policies.

As indicated in Figure 4.2, the data automation needs required of the Yampa River Basin Project differ from the wider and more general Upper Colorado Study in these respects:

1) The Yampa project needs more localized data, finer resolution and combinations of industry, agriculture, urbanization and water use plans, as well as information of their impacts on fish and wildlife habitat.

2) The Yampa project requires the defination of: a) patterns of wildlife habitat; b) state and federal programs dealing with mineral, transport, water and urbanization planning; c) education of the recreational public (organizations); d) aiding in setting goals for the Area Offices of FWS and the Game and Fish agencies of states regarding mitigation sites, refuges, criteria for reviewing any engineering and land leasing projects.

The specific needs programs of the Yampa Study are in Report 1.3.

4.4 Regional Realty Office

The primary function of the Realty Office is to serve as a repository for deeds, easements, and land status (ownership, location, land use and acreages) of lands under FWS jurisdiction as well as for potential purchases and easements.

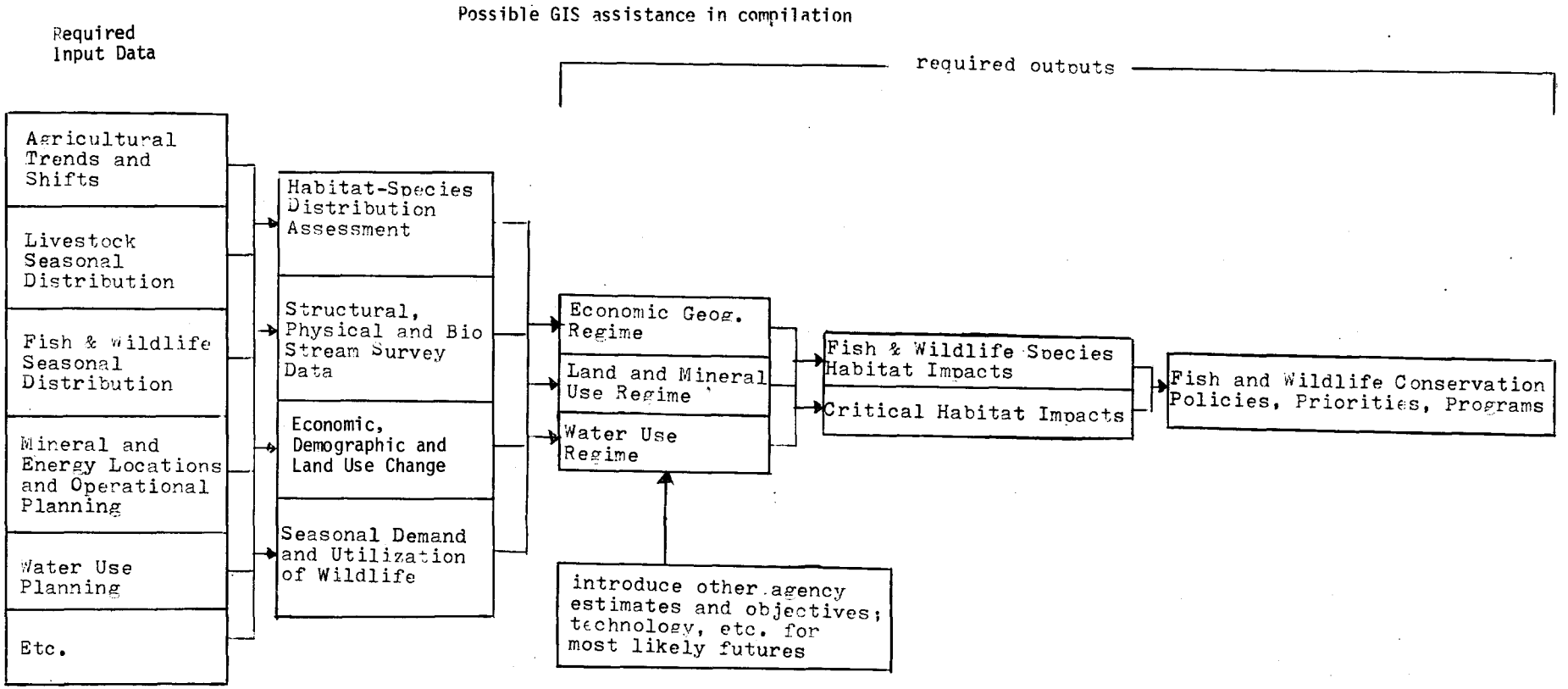
The above data are stored for FWS refuges, game ranges and the five million acres of wetland resources under easement programs or owned by the FWS as part of the Wetlands Preservation Program.

The repository of information at the Regional Realty Office presently consists of xeroxed copies of field notes and aerial photographs for each parcel of land under FWS jurisdiction. Frequent updating of this information is required for determining and monitoring potential wildlife habitat changes that may occur on FWS lands. It appears from the survey, that the relative effectiveness of existing survey and analysis techniques could be improved by a GIS.

4.5 Regional Fisheries Division

The major responsibility of the Regional Fisheries Division is the

Figure 4.2 Ecological Services/ Yampa River Basin Project



and 3 fish hatch development centers. Projects or activities funded in part or entirely by the Fisheries Division include:

1. Support services;
2. Studies aimed at improving hatchery production and distribution;
3. Activities involved with the production of eggs, fry and fish at National Fish Hatcheries;
4. Distribution of hatchery-reared eggs, fry or fish to Federal, State, or Indian waters;
5. Fish habitat and population management.
6. Enforcement of Fish Laws, and;
7. Technical assistance to outside agencies and individuals.

Because the Regional Fisheries Division is primarily concerned with appropriations and disbursement of funds to hatcheries, they use or produce very little spatial data. Consequently, a GIS would be of marginal use. However, useful data that could be supplied by a GIS would be aquatic habitat maps. A more detailed description of the Regional Fisheries programs and data needs are in Report 1.3.

4.6 Regional Federal Aid Office

The Federal Aid Office in the Division of Federal Assistance and Endangered Species does not have any formal set of specified programs in an annual work plan. Programs are essentially determined by requests from State Game and Fish Departments that need federal aid for their various programs. These requests for aid include the following:

1. Comprehensive long-range fish and wildlife management plans;
2. Recovery plans for game or non-game species;
3. Research programs regarding the monetary value for sport, and recreational fishing;
4. Funding for a wide variety of FWS research programs such as the production of foreign game birds, constructing and upgrading wildlife research facilities;
5. Acquisition of Fisheries and Wildlife Management land, and;
6. Wildlife education and hunter education programs.

Due to the diversity of programs dealing with non-spatial data, the Federal Aid office is not looked upon as a strong user of a geographic information system. Their detailed data needs are shown in Report 1.3.

4.7 Regional Interpretation and Recreation Office

The goal of this regional office is to continue upgrading fundamental visitor facilities on FWS land to provide simple outdoor experiences in a safe, pleasant and quality atmosphere. The major tasks of this regional office are:

1. To develop educational programs for the general public and school groups;

2. To develop programs for the preservation of historical/ archeological sites on FWS lands;

3. To develop programs for improving visitor services on FWS lands, and;

4. To develop a systematic approach for Comprehensive Master Planning for refuges.

A detailed description of the programs, tasks and needs of the Regional Office is in Report 1.3. The primary uses of a GIS for this office would be for the production of maps and for developing Comprehensive Master Plans for refuges.

4.8 Potential Data Interactions Between Regional Office and Area Offices.

Under previous and ongoing Regional Office operations, the majority of data analysis is performed by the Area Offices, while the Regional Office looks into new methods, policies, priorities and budgets. Recently, however, Regional Office advance planning studies such as the Upper Colorado Basin and the Yampa Basin have begun to require much more two-way data interchange between levels in the FWS. One of the purposes of this project (WELUT 2-76) is to provide automated means for such interchange.

5.0 OBS SPECIAL OFFICES

The Biological Services Program of FWS includes 1) the Office of Biological Services in Washington, D.C., which is responsible for overall planning and management; 2) Regional Activity Leaders who delineate Regional resource problems; and 3) the four National Teams which are concerned with specific environmental areas. One of these teams is the Western Energy and Land Use Team (WELUT) which has the mission to promote effective considerations of fish and wildlife resources in decisions concerning utilization of western coal, oil shale, and geothermal resources, in allocating water resources for energy and agricultural development, and in other changes in land use.

The special offices surveyed in this project include the Habitat Assessment Group, Instream Flow Service Group, and the Wetland Inventory Survey. A detailed description of these three offices and their needs for a geographic information system follows.

5.1 Results of Habitat Assessment Group Needs Assessment

5.1.1 Organizational Description

This organization was initiated in January, 1976 following acceptance of the basic conceptual approach as presented in an issue Paper entitled "Proposal for a Habitat Classification and Evaluation Project". The functional unit for this project is the Habitat Assessment Group located in Fort Collins, Colorado.

The goal of this organization is to significantly improve the manner in which FWS addresses its role in environmental impact assessment and resource management by (a) providing information to users early in planning phases of proposed projects or management programs; (b) strengthening the quantitative capabilities for predicting consequences to fish and wildlife from major land and management changes; and (c) coordinating the assessment of fish and wildlife habitat nationally in cooperation with state and federal agencies.

5.1.2 Program Description

5.1.2.1 Responsibilities Mandated The need has long existed to consider and use sound ecological information in decisions considering policy, planning and operational management of our natural resources. This concept is the subject of several significant laws including the Fish and Wildlife Coordination Act of 1934 as ammended, the Endangered Species Acts of 1973, the U.S. Forest Services Multiple Use Act of 1960, the Forest and Rangeland Renewable Resources Planning Act of 1974, the Marine Mammal Protection Act of 1972 and the National Environmental Policy Act of 1969.

5.1.2.2 Staffing The staff of the Habitat Assessment Group consists of: 1 leader, 1 plant ecologist, 1 aquatic ecologist, 1 physical scientist, 1 wildlife biologist.

5.1.2.3 Major Tasks and Timetable The major tasks of the Habitat Assessment Group are to design a common descriptive system for habitat and a data base and approach from which the assessment of the diverse impacts on fish and wildlife resources may be determined, by divisions of FWS or other agencies. More specifically this means: (1) The compilation of a comprehensive system for classification, inventory, and analysis of fish and wildlife habitat and (2) the production of geobased information system for habitat data. These systems will permit functional units of FWS to assess the impacts of energy or other development activities. Such regional analysis can only be properly accomplished if a uniform and intercomparable data base and method exists for all impacted areas and resources.

Further elaboration of project programs and work elements can be obtained from Report 1.3.

5.1.2.4 Operational Analysis of Present Program As mentioned in the annual work plan, the scope of the program will be a comprehensive, ecologically based, hierarchial classification system for fish and wildlife habitat of the United States. It will be produced through a computerized geo-base information management system for accessing habitat data, analyzing data, and making it available to resource management decision makers. This is the point where the WELUT 2 project could be utilized by the Habitat Assessment Group, although HAG would probably not be an opeational user of the compilation data modules in the same way as the BAO and Region 6 sections. Instead, HAG would be a supplier of habitat data and methodologies used in the development of data compilation modules. (See Figure 5.1).

5.2 Results of Cooperative Instream Flow Service Group Needs Assessment

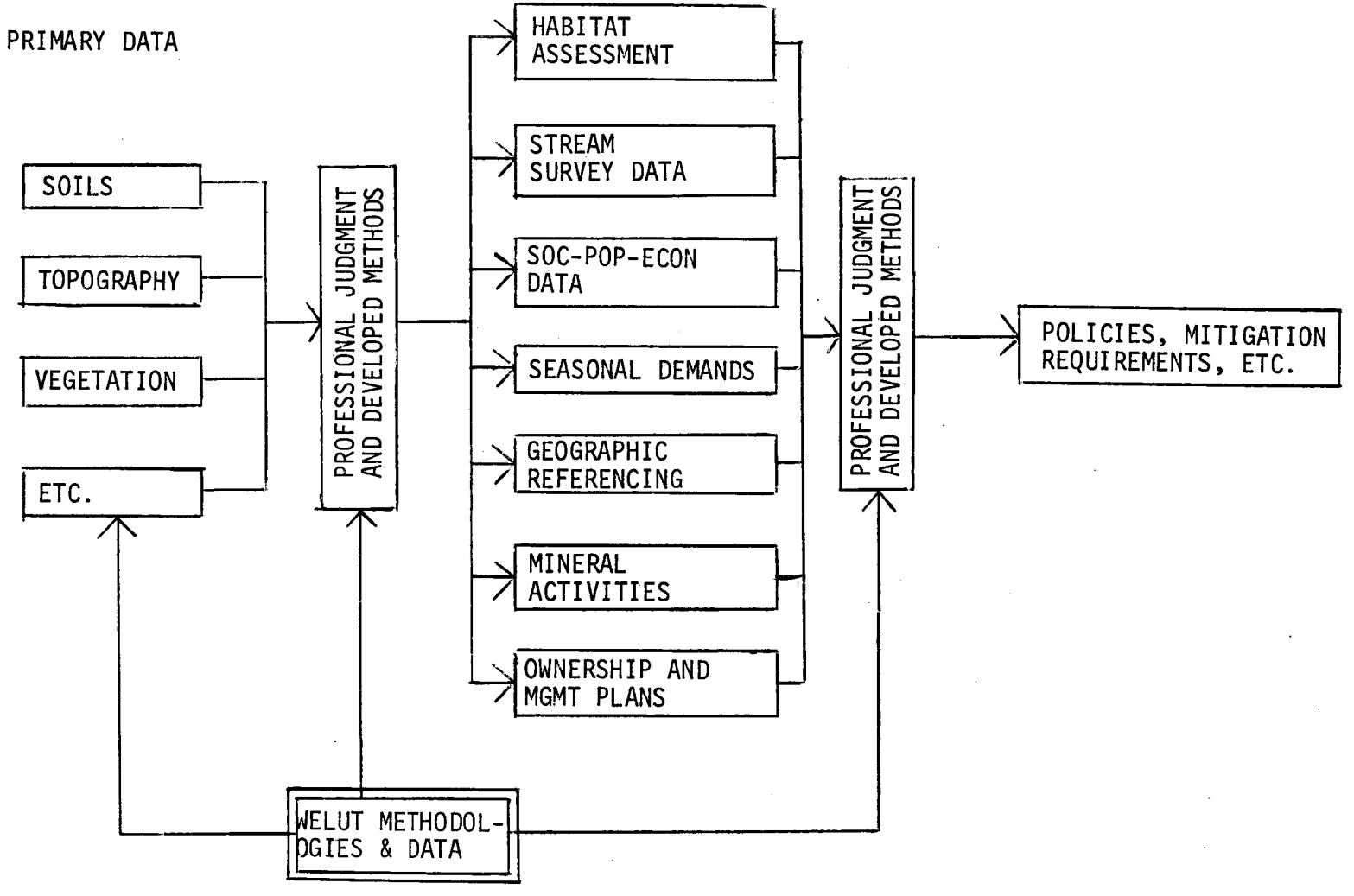
5.2.1 Organizational Description

Historically, water rights were obtained in the western United States through a state appropriation for the purpose of using the water out of the stream for some "beneficial use", defined by state law as normally including municipal, industrial, stock watering, agricultural or mining. However, stream and associated riparian ecosystems, recreation, and aesthetics have only recently been recognized as beneficial uses of water, in some states. These uses and several others which depend on flow are often referred to as "instream uses".

Several goals of the Cooperative Instream Flow Service Group are: (1) to provide services to entities concerned with the identification of instream requirements for fish and wildlife through improved methologies, and (2) the implementation of recommendations for instream use by fish, wildlife, acquatic organisms, recreation, and aesthetics in all major United States streams.

5.2.2 Program Description

Figure 5.1 Illustration Showing Input of WELUT Methods and Data Into Data Compilation Modules



5.2.2.1 Responsibilities Mandated Recent legislation and court decisions have pointed out the need for identifying instream flow requirements and quantifying their magnitude. Specifically, these include: 1) the Fish and Wildlife Coordination Act; 2) various state legislation concerning instream flow; 3) Department of Interior Westwide Water Study Recommendations for instream flow study; 4) ERDA Enabling Act, Section 13; A,B,&C and; 5) the Non-Nuclear Energy Act. With legal recognition that instream uses should be considered on a par with offstream uses came increased demand for methods to supply water resource agencies and planners with information to (1) determine relationships between benefits derived from instream uses and stream flow quantity, and (2) determine the optimum allocation of limited water resources among various instream and offstream uses.

5.2.2.2 Staffing The IFSG is composed of persons with a variety of backgrounds to address the areas of instream flow needs. Staffing includes: 2 acquatic ecologists, 1 hydrologist, 1 wildlife ecologist, 1 legal specialist, 1 acquatic systems analyst, 1 recreation planner, 1 hydrologist technician, 1 secretary.

5.2.2.3 Major Tasks and Timetable To achieve the major goal of the Cooperative Instream Flow Service Group specific objectives or tasks were identified in the three year work plan. These are:

1. To develop improved methods for assessing instream flow requirements for fish and wildlife;

2. To develop and improve guidelines for implementing instream flow recommendations;

3. To establish an effective communication network for disseminating instream flow information, and;

4. To help the National Water Resources Council with Level A type planning data.

Further descriptions of project programs and work elements can be obtained from Report 1.3.

5.2.2.4 Operational Analysis of Present Program The requirements of a geographic information system by the Cooperative Instream Flow Service Group are very similar to those of HAG. The major IFSG effort is to develop a classification scheme appropriate for assessing instream flow needs. Other IFSG efforts are oriented toward education and providing advice on the legal defensibility of instream flow recommendations. Some of the IFSG outputs will include inputs into a geographic information system as illustrated earlier in Figure 5.1. In addition to methods IFSG would also utilize a GIS as a center for disseminating instream flow information to state and federal agencies and segments of the private sector which is concerned with instream uses.

5.3 Results of Wetland Inventory Needs Assessment

5.3.1 Organizational Description

In 1954 the U.S. Fish and Wildlife Service conducted an inventory of the wetlands of the United States. Since then, wetlands in this country have undergone considerable change, both natural and man related, and their characteristics and natural values have become better defined and more widely known. In this interval since 1954, many states have passed legislation to protect wetlands and a few have also produced state wetland surveys.

In 1974 the U.S. Fish and Wildlife Service directed its Office of Biological Services to design and conduct a new national inventory of wetlands. While the single purpose of the 1954 inventory was to assess the amount and types of valuable waterfowl habitat the scope of the present project is vastly broader. Hopefully, it will provide data that will be useful to wildlife managers, hydrologists, landscape planners, economists, engineers and many other workers in public and private agencies and organizations.

The National Wetland inventory was established in 1976 and is located in St. Petersburg, Florida.

5.3.2 Program Description

5.3.2.1 Responsibilities Mandated As indicated in a previous section, many states have or are in the process of producing legislation to protect wetlands. Other mandates related to a wetlands inventory include: the Fish and Wildlife Coordination Act of 1934 as amended, the U.S. Forest Services Multiple Use Act of 1960, the Forest and Rangeland Renewable Resources Planning Act of 1974 and the National Environmental Policy Act of 1969.

5.3.2.2 Staffing The staff assigned to the National Wetlands Inventory include: 1 project leader, 1 information specialist, 1 remote sensing specialist, 1 project coordinator, 1 administrative secretary and 5 part-time photo interpreters.

5.3.2.3 Major Tasks and Timetable The National Wetlands Inventory Project is aimed at classifying and mapping all wetlands with the 50 United States. The Wetland Inventory team is currently working in Florida. Florida was selected as a staring place because of the diversity of wetlands within the state. The priorities at this time are: 1) Central Florida, 2) Georgia Islands, 3) Coal area in Montana and Wyoming. The four major categories in the classification system are: 1) Marine, 2) lacustrine, 3) riverine, 4) palustrine.

Interpretation and mapping of wetlands is being done on 1:60,000 to 1:130,000 scale color infrared photography. Currency of photography was flown in 1974 or more recent if possible. Photography will be obtained from outside agencies when possible and flown on a contract basis for areas where CIR photography is not available. The method of

updating will be first to detect areas of change on Landsat CIR imagery and then to use CIR low altitude photography for making map changes.

A more detailed description of the program and work elements is in Report 1.3.

5.3.2.4 Operational Analysis of Present Program

While many of the elements within the Wetland Inventory Project (WIP) are not automatable, the dissemination of the inventory maps is indeed automatable. The WIP will be producting both polygonized digital tapes and 1:100,000 scale paper maps. The wetland maps are seen to be useful in several compilation data modules. For example, as a primary data component of the Habitat Assessment Module; the Stream Survey Module, and the Geographic Referencing for Realty Module. The WIP maps would be especially useful for realty pruposes in the Waterfowl Production Area Program, where delineation surveys are needed for identifying all significant waterfowl production areas.

6.0 DEVELOPMENT OF DATA COMPILATION MODULES

Essential Nature of a Data Compilation Module

6.1 Many office procedures studied during this survey (see sections 3.0, 4.0, and 5.0) indicated the need for a set of pre-compiled indicators which would map out "land use" or any complex biological, physical or social phenomenon. The pre-compiled procedure would eliminate the current problems of having to collect and compile by hand much spatial data such as soils, topography and vegetation cover. The automated "data compilation module" (DCM) would provide for intermediate grouping and restructuring of many data items into a composite indicator map or table. Essentially, the DCM would compile many data items into a few manageable bundles which are suitable for automation when a volume of raw maps, uncorrelated data tables and reports overflow the desk top of the biologist. Data compilation modules may be said to lie in the "middle" of an automated system; i.e., between the input (raw data) and the output (composite maps, statistical tables, and other evaluations).

Essentially, a data compilation module carries out the following processes:

1) Conversion of all required maps and remote sensing into uniform scales and geographic projections; conversion of the non-compatible data legends into common legends; changing legends categories from descriptive to ordinal values when necessary; and rectifying several maps to common geographic control points.

2) Combination of several base maps such as soils, vegetation, slope and micro climatic into a standardized habitat classification map. This process of combining may use standard weighting procedures as defined by HAG research and methodologies or be based on field biologists' professional judgments. This predefined combination of raw input data into a standard classification will be designed to satisfy the majority of users. Other specialized or research users may wish to develop their own weighting scheme, different sets of variables or special simulation models to combine variables. These specialized users could go back to original source data whenever desired and create new or different compilation modules.

3) Statistical Analysis is a valuable capability of a GIS that allows decision makers the capability to discern relationships that exist between base maps. For example, various statistical procedures can be used to reveal relationships that exist between indices to fish or wildlife habitat quality and the physiographic, edaphic, biologic or land use characteristics of

an area. These capabilities can provide valuable inputs to computer models and determine the most important variables for a particular analysis.

4) Modelling and Simulation are powerful tools for dealing with highly complicated or complex problems such as predicting changes in land use or human demands for fish and wildlife resources over time. The data storage and analysis capabilities afforded by a GIS provides a foundation for the development of models or simulators that utilize spatial data.

As a result of the structured survey of the BAO, Regional Offices and the OBS Special Project Offices (see sections 3.0, 4.0, and 5.0) seven data compilation modules have been identified as useful for early demonstration.

6.2 Habitat-Species Distribution Assessment Module

6.2.1 Nature of Module

The general purpose of this module is to develop a comprehensive picture of habitat quantity and quality which is needed for various FWS programs.

Wildlife habitat and species distrigution information are currently or potentially important to:

1) the Ecological Services' Habitat Evaluation Procedure (HEP)

2) the wildlife impact assessment procedures of the Northern Powder River EIS team;

3) the areawide planning activities of Ecological Services;

4) the assessment of wildlife habitat and range conditions in the National Wildlife Refuge System;

5) the endangered species program, especially the recovery plan for the Northern Rocky Mountain Wolf; and

6) the regional planning activities in the Yampa and Upper Colorado River basin.

7) acquisition of lands for migratory bird protection areas.

Also, various WEULT projects, Habitat Assessment Group and Cooperative Instream Flow Service Group are studying wildlife population levels, their seasonal distribution, and relationships with habitats. The interim results, advice and techniques developed by these two groups has been, and will be used extensively.

Within these cases the character, scope and scale of habitat and species information varies greatly. However, several common needs are apparent:

(1) to conduct a fast and cost-effective evaluation;

(2) to allow for the rapid comparison of alternate resource dev. plans;

(3) to allow for the assessment of both regional and site-specific wildlife population and habitat conditions;

(4) to reconstruct the habitat evaluation process upon request; and

(5) to interface seasonal species distribution information with habitat information to determine critical seasonal ranges or migration patterns.

Current methodologies for assessing wildlife habitat do not satisfy all these needs. A large part of the problem is that there are currently no capabilities within the FWS to efficiently handle the vast amounts of field and map data associated with wildlife habitat evaluation.

The habitat assessment techniques proposed here are not meant to replace current systems of evaluating habitat. Rather, they are intended to complement existing methodologies by addressing the above needs. In the process, we anticipate that new assessment capabilities may emerge as the advantages of computer storage, handling, and manipulation of data are demonstrated.

There are two major components of this test application: habitat classification and wildlife species distribution mapping. In the context of this report, habitat classification is the process of identifying ecological units that are homogeneous with respect to the seasonal food and cover requirements of wildlife. These ecological units are commonly referred to as habitat types, vegetation types, or habitat classes. In any event, whenever vegetation is assessed for its suitability to support wildlife, habitat classification is employed to provide a convenient basis for collecting and summarizing wildlife data.

While the specific combination of factors that influence a particular species of wildlife may not be fully known, a habitat class and its productivity generally may be defined as a function of some or all of the following variables:

- vegetation composition,

- vegetation density,

- vegetation successional stage,

- inherent soil fertility,

- soil moisture holding capacity,

- precipitation,

- elevation,

- steepness of slope,

- aspect of slope,

- microclimate extremes.

It is possible to inter-relate these data and maps via overlaying to analyze relationships, to provide habitat classiciation maps and, with input from field evaluations, to indicate subarea capacities to support certain species of wildlife. Such procedures will be faster, more sensitive and more objective than the manual procedure now used to collect field data and make desk-top interpretations. Computer retrieval and manipulation of these variables will offer practical ways to compute and map out the habitat edges, interspersions, juxtapositions, and other relationships sought by the biologist. In addition, these data will be amenable to aggregation and extrapolation, permitting the assessment of likely regional impacts of a project or a decision on wildlife resources.

This module does not attempt to prescribe the classification formulae for given wildlife species habitats, since the precise definition of the factors necessary to classify and evaluate wildlife habitats has not yet been resolved. However, several organizational elements of FWS are conducting investigations to provide these kinds of data. Ecological Services is sponsoring applied research programs to obtain Key Habitat Criteria Handbooks for each habitat type in the United States. The Habitat Assessment Group of OBS is conducting research to:

1) identify the biological and physical data necessary to classify wildlife habitats; and

2) relate habitat types to spatial and temporal factors influencing the value of an area for wildlife.

The Land Management Division of BAO is using soil survey data to summarize and assess the potential of different areas of the C. M. Russell National Wildlife Refuge to accommodate both wildlife and livestock grazing. These and other related efforts suggest that current information and methodological voids will soon be filled.

Closely connected with habitat classification and analysis is the problem of wildlife species distribution. Among operational divisions, the following are depending frequently upon estimates and references of species distribution:

1) Ecological Services in their area-wide planning activities and their reviews of new applications for reservoirs, permits & licenses

2) Land Management in planning land leases and acquisitions, and making refuge plans

In the near future, several WELUT studies will contribute to the methodology of species distribution:

1) Seasonal Fauna Distribution (WELUT 008-77)

2) Line transect methods (WELUT 009-76)

3) Effects of Coal Extraction and Related Development on Wildlife Density (WELUT 012-76)

4) Northern Great Plains Breeding Bird Survey (WELUT 047-76)

It is necessary for an automated system to be able to interrelate habitat and wildlife species - both through statistical search for meaningful correlation (seasons, plant communities, species groupings, etc.) and through compositing according to the judgment of biologists and managers.

As in habitat classification, vegetation, climatic, landform and water regimes may be ranked according to their capacity to support seasonal populations of various wildlife species. Then, it is readily possible for an automated data and mapping system to interrelate habitat and species maps, based on explicit instructions of biologists or managers. This process would serve to refine the habitat classification map by identifying critical habitat for species, such as winter ranges, migration routes, wetland water depletions, etc. It may also be possible to develop statistical regressions of habitat factors and species distribution to clarify and predict the influence that any given change would have on wildlife population levels.

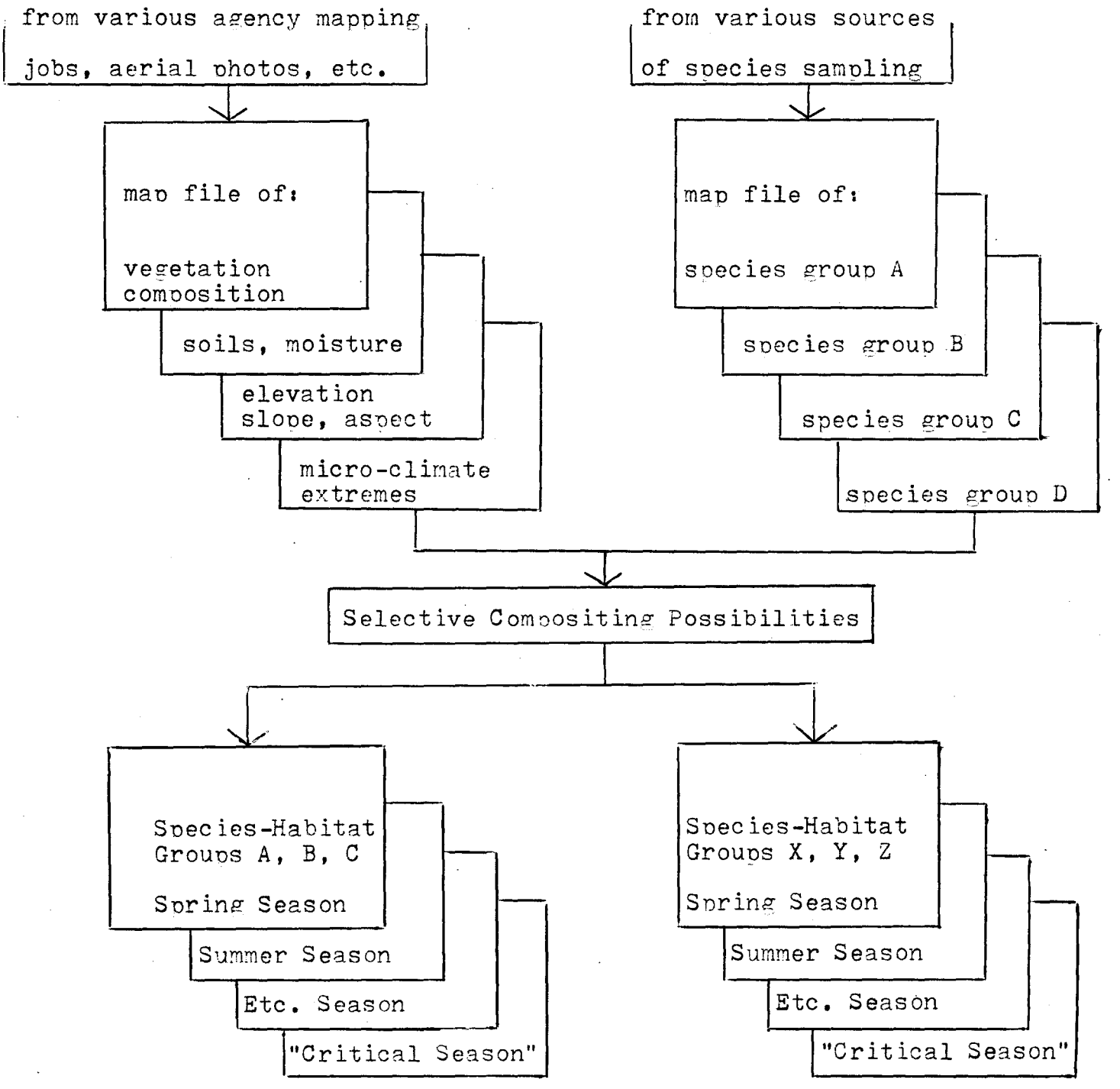
A systematic approach to habitat classification and species distribution mapping provides a viable mechanism for rapidly assessing regional and site-specific habitat conditions. Considering the prevalence of habitat assessment in the Fish and Wildlife Service, such a system seems to be urgently needed. See figure 6.1 for a descriptive flow chart of the Habitat-Species Distribution Assessment Module.

6.3 Stream Structural, Physical, and Biological Survey Data Module

6.3.1 Nature of Module

As a result of the Fish and Wildlife Coordination Act of 1958, the U.S. Fish and Wildlife Service has a mandate to evaluate and report on the fish and wildlife impacts of water development projects requiring federal permits or licenses. Activities requiring a federal permit include stream dredge and fill operations, rip-rap installation, dike, dam or jetty construction, channelization or any other operation resulting in stream alteration.

Figure 6.1 Habitat-Species Distribution Assessment Module



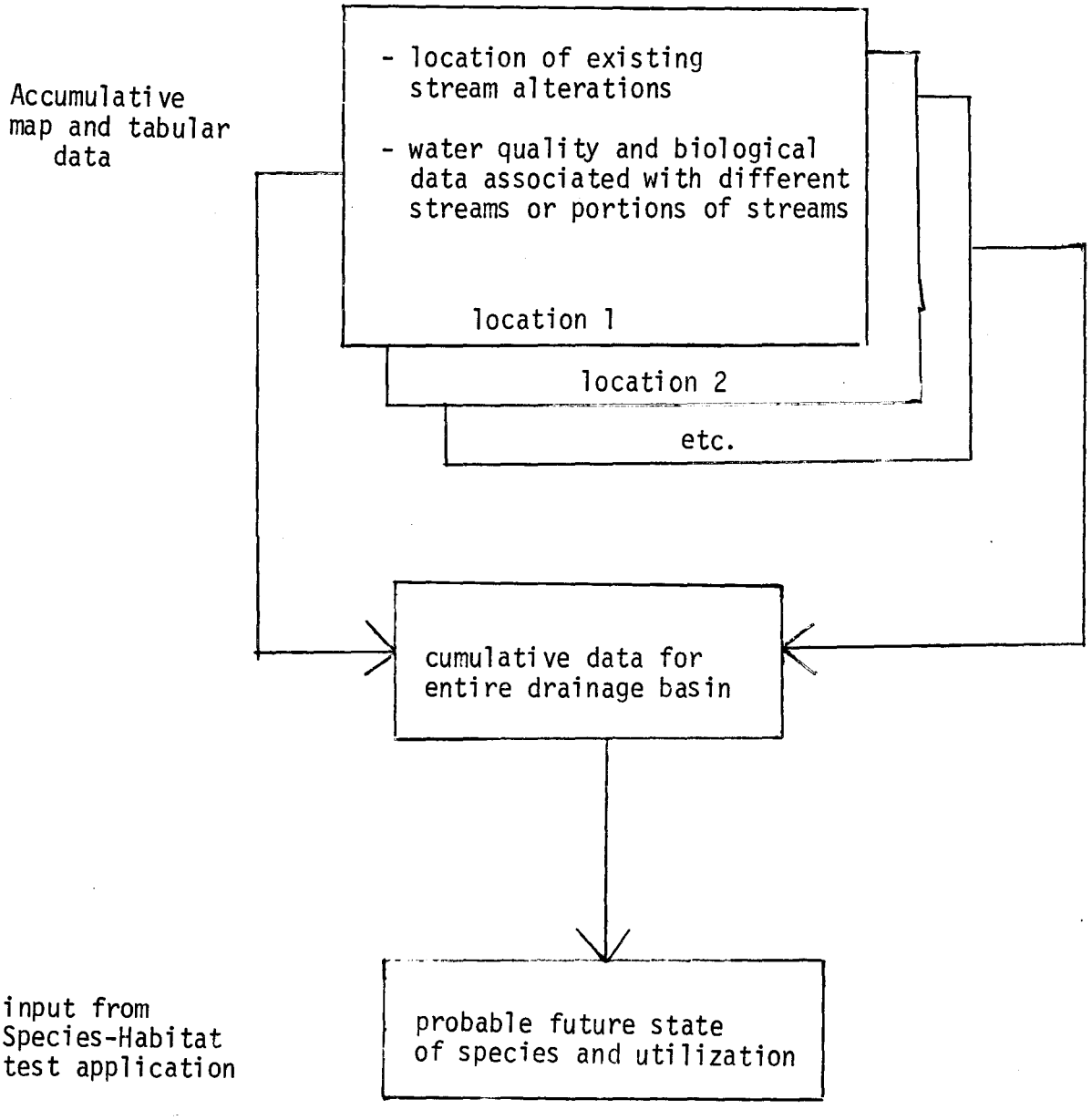
Evaluations of these projects are prepared in the Area Office by the Ecological Services division of the Fish and Wildlife Service. The HEP procedure is used to evaluate dam or other water projects having major local and regional impacts. In addition, Ecological Services receives scores of requests each year to evaluate and report on the effects of smaller alterations of streams (e.g. rip-rap, dredge and fill, etc.). Although individually these projects may have little impact on fish and wildlife resources, the cummulative effect may be great. Currently, the Fish and Wildlife Service assesses the localized impacts of the developments. The problem is two fold: first, the large geographic distribution of stream alteration (all Montana and Wyoming) and the short amount of time (30 days) given to respond to permit requests precludes an extensive evaluation. Second, no data is currently synthesized and stored to allow for the rapid retrieval and evaluation of both the site-specific and cumulative impacts of development.

Capabilities can be designed into an automated geographic information system to permit the rapid evaluation of local and regional fish and wildlife impacts of stream alterations occurring throughout Montana and Wyoming. Essentially, this system would draw on data bases describing (1) the location and characteristics of existing stream alterations and (2) the hydrologic, biologic, and riparian characteristics of a stream. These data are available for many streams in a computerized format from the Army Corps of Engineers and the Montana and Wyoming state fish and game agencies, respectively.

Simple compositing of elements contained in these data bases provides a basis for identifying site-specific conflicts between proposed stream alterations and scarse or important biologic or hydrologic regimes. The extensive nature of the data base would also facilitate data aggregation, permitting the assessment of likely regional and cummulative impacts.

These data and methodologies would do much toward improving the present process of assessing the impacts of stream alterations. In addition, methodologies being developed by the Cooperative Instream Flow Service Group in Fort Collins, Colorado, will provide a basis for determining minimum flow requirements for sustaining fish and wildlife. Integrating this process and information into the geographic information system will add still another dimension to the fish and wildlife assessment procedures. See figure 6.2 for a descriptive flow chart of the Structural, Physical and Biological Stream Survey Data Module.

Figure 6.2 Structural, Physical, & Biological Stream Survey Data Module



6.4 Economic, Demographic and Land Use Patterns

6.4.1 Combined Nature of this Module

The three elements of employment, population, and land use are inseparable, for modelling. Land use changes are highly dependent upon the shifting industrial base and resulting population. Underlying all this is the natural geography and the main infrastructure, transportion facilities, water, power, etc. There is no single "best procedure" for modelling these relationships. An example procedure is set up to illustrate how the information system (tables and maps) may be used.

Example Procedure and Data Elements (following Fig. 6.3)

(Steps 1 through 9 are aggregate estimates of future employment and population for an entire study area. In a dynamic economic region these aggregate projections will usually be given by other studies. But these steps show how the module might do it.)

1. Basic Employment means those area economic activities which export most of their goods or services from the region. These are the main "controllers" of area growth. The user defines the main industries and presents data tables on their employment, for example:

   (c) Coal Mining (surface) 1965 county employment 200, 1975 employment 950.
   (e) Thermal power plants, etc.
   (f) Timber harvesting, etc.
   (a) Agriculture, etc.

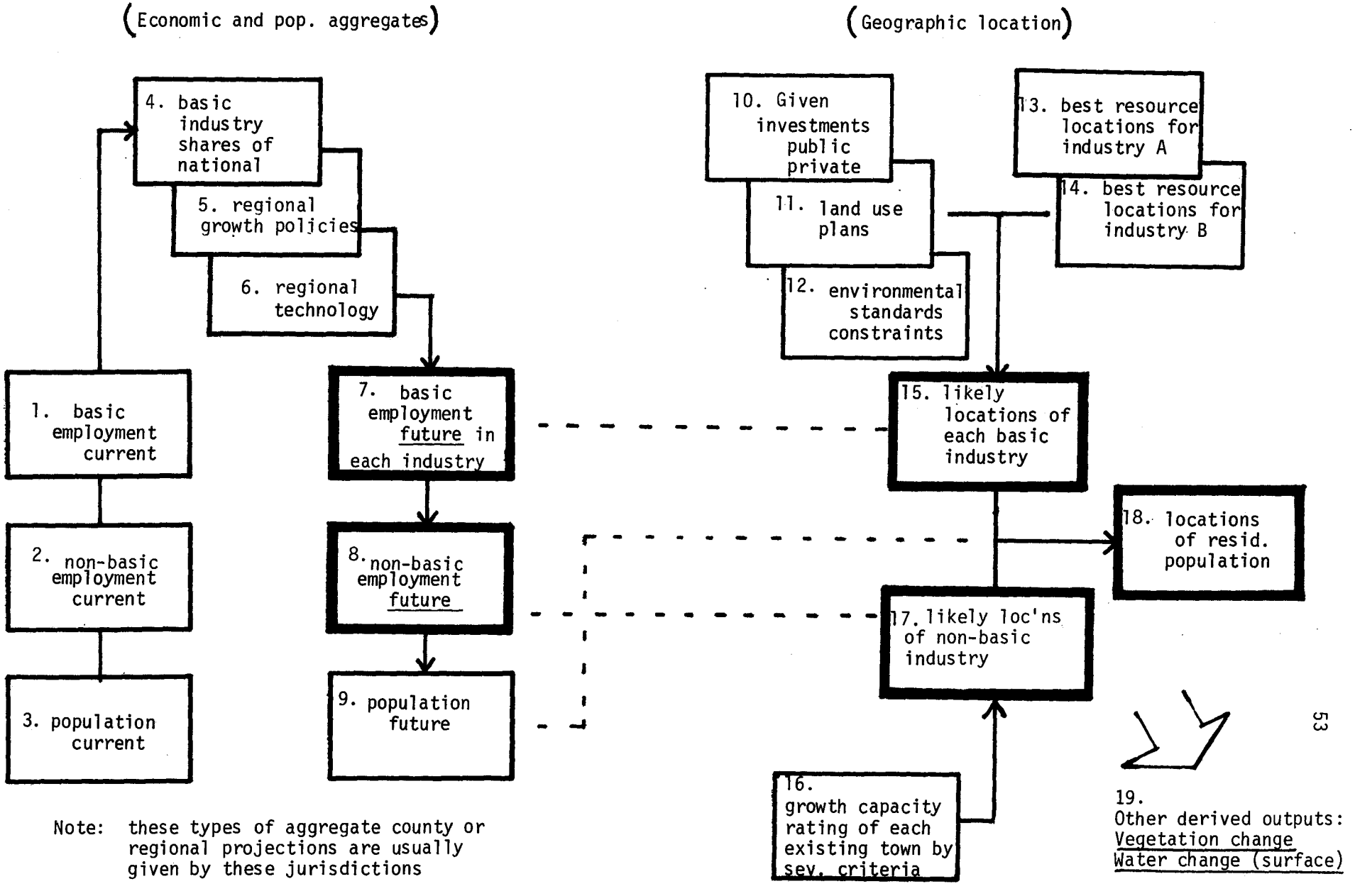
2. Non-basic Employment. It may be OK to treat all non-basic (local) employment as a lump total including the usually construction, services and other essentially local categories. The historical ratio between basic employment and non-basic employment may be derived from employment (census). Other comparable regions may be checked for similar ratios.

3. Population, Current. The current resident population which corresponds with the employments (basic and local) bear a certain ratio to total employment, for example 2.5. Present population in a boom area may be out of balance with the employment: a rush of young working-age migrants not having the normal complement of children and aged as in normal regions.

4. Local Share of National Industries. If the regional share of national or wider coal production employment is currently x percent, what is it likely to be at a future date? This is a key judgement. This may be given by regional economic reports; in fact, such reports will exist in any very dynamic region.

Fig. 6.3

ECONOMIC-DEMOGRAPHIC-LAND USE MODULE (see also narrative steps)



Note: these types of aggregate county or regional projections are usually given by these jurisdictions

5. Regional growth Policy. The above Share calculation is now a "base" which may be modified by other factors such as "support policies" of the state and locality, such as plans, budgets for infrastructure, labor training, etc.

6. Regional Technology is another modification of Share. Any extra-ordinary local technology advantage may increase the local share of production, and may also change the labor-output ratio. (Such changes must be local and unique, in order to alter the Share.)

7. Basic Future Employment. Now it is possible to estimate future basic employment in a given industry (coal) by modifying the Share. In short,

the growth factor $F = f(S, G, T)$

where S is the first estimate of Share, modified by growth policy G, and further modified by technology T. Each basic industry may be projected to the target date by this procedure.

8. Non-Basic Employment may be estimated by applying a selected ratio of (1) to (2). This must be done carefully, as the multiplier may range from 1.5 to 3.0. Care must be used in the selection of the ratio, particularly where the "current ratio" is obviously abnormal, i.e. where there has not been enough time for service and construction employees to arrive on the scene. The history of "normal" areas must be examined to find their basic-local ratios.

9. Population, Future. Applying another representative ration found elsewhere, related population to total employment, yields a future population estimate. Note that this does not yet account for large seasonal recreational population which may be important in estimating the utilization of F & W.

GEOGRAPHICAL ALLOCATIONS

While steps 1-9 gave "aggregate" numbers of future employment and population, tye did not yet distribute them geographically. This will be described via the following steps, usually requiring cellular overlay mapping.

10. Given Investments, Private, Public. The committed locations for new investments may be mapped on a base map: a new municipal water system and its service zone, a new railroad line and its service corridor, etc.

11,12. Land Use Plans. Similar to (10), a county land use plan is another geographic constraint which may be overlayed on the region. Major agency land use plans and regulations should be overlayed as constraints. BLM, Bureau of Reclamation, Forest Service, State Transportation Plans are all significant constraining agencies.

13,14. Best resource locations for particular industries may be mapped from private and public maps and reports. Will be very useful for composite mapping to find early or most likely areas of industry.

15. Likely Locations of Each Basic Industry. On the basis of the previous tabular data and maps, it is possible to use computer map compositing and weighting to indicate likely locations of the basic industries, (and subsequently, employment). One example approach would be to map the most efficient potential locations of an industry; essentially to map the locations of highest ratio of "output" relative to "costs". Following would be the steps:

(a) The mapping objective: to distribute the employment growth increment of each important basic industry to the "most "efficient" locations, defined as those locations having high output/cost ratios.

(b) This is started by mapping out the quality resources for each prospective industry, resulting in a "resource potential map".

(c) Then required inputs or "costs" of transport, water, labor access, land costs, engineering difficulties and cost of environmental protection or repair, etc. are mapped. These may include F & W constraints, land reclamation costs and mitigation site costs associated with any given industrial location, etc. All these constraint maps may be given relative "weights" or penalty points in a composite map of "costs".

(d) Now it is possible to "subtract" the cost composite map from the resource potential map to find a difference gradient; the largest "difference locations" would best satisfy the objective - and the growth increment for that industry (say employment) would be allocated to the cells of highest, next highest, etc. value according to a "logical" sub-routine set up for the computer. I.e., this routine would distribute all of the growth increment in basic employment for that industry (from step 7.)

(e) This would be repeated for each basic growth industry.

(f) Finally, a summary composite map would show the basic employment growth over the "most efficient" industrial locations of the region. (This maps out basic industry growth only.)

16. Growth Capacity Ratings of Existing Towns. Given the employment growth increment in Local Industry and Services (from step 8) it may be assumed that (a) most of these activities will be in urban nodes, (b) there are already enough nodes to choose from, and (c) the location problem narrows down to "grading" the efficiency or growth capacity of these nodes. This means setting a few criteria for ranking the "growth capacity" of the existing towns, such as:

(1) Efficiency of transport junction (an ordinal ranking)

(2) Efficiency of urban water supply system

(3) Efficiency of urban sewer system

(4) Growth capacity of school system

(5) Quality/capacity of health services

(6) Quality/capacity of shopping and business services

(7) Available "building table"

(8) Nearness to large expected basic industry locations.

This results in a "growth capacity ranking" of nodes.

17. Likely Locations of Non-Basic Employment. By a "logical" allocation subroutine, the computer can distribute the regional growth increment in this type employment (from Step 8) to the urban nodes, according to their capacity ranking (from Step 16).

18. Locations of Residential Population. The growth increment of total population (from Step 9) may also be distributed to the urban nodes, according to their capacity ranking (from Step 16). This simply assumes that the long-term resident population settles at most efficient locations. The exception is temporary construction camps of mobile homes which may be mapped as given (if so given and condoned by the county plan).

19. Other Outputs: Vegetation and Surface Water Changes. To further assist the wildlife biologist in estimating impacts upon fish and wildlife habitat, it is possible to derive very coarse patterns of:

Vegetation - gross changes around industrial, transportational urban and agricultural locations (from steps 10,11,12, particularly 15,17 and 18)

Surface Water - indications of local increase/decrease of seasonal water distribution in zones of changed industry, agriculture, urbanization, railroad or highway embankments; applying standard coefficients of demand, effluent, runoff, etc. May be further evaluated by biologists and hydrologists.

6.5 Seasonal Demand For And Utilization of Fish and Wildlife Resources Module

6.5.1 Nature of Module

The "demand" side of fish and wildlife analysis is often the weakest side of the supply-demand relationship, yet, it is everywhere inferred as justification for wildlife conservation. This test would estimate and map the distributions of seasonal human utilization of various resources. It would do this by steps, using the following variables and other modules in the geographic information system:

1) Seasonal demand coefficients from other studies (WELUT, Bureau of Outdoor Recreation, State Game and Fish)

2) Near future estimated resident and seasonal visitor population (for state and regional demographic and planning studies of trends)

3) Species/Habitat seasonal maps (from Habitat-Species Distribution Assessment Module).

The logical sequence of relationships among these variables lends itself to computer processing. It is probable that many elements of data have been available for systematic estimation of seasonal demand locations, but have remained under-utilized because of the limitations of desk-top manual methods.

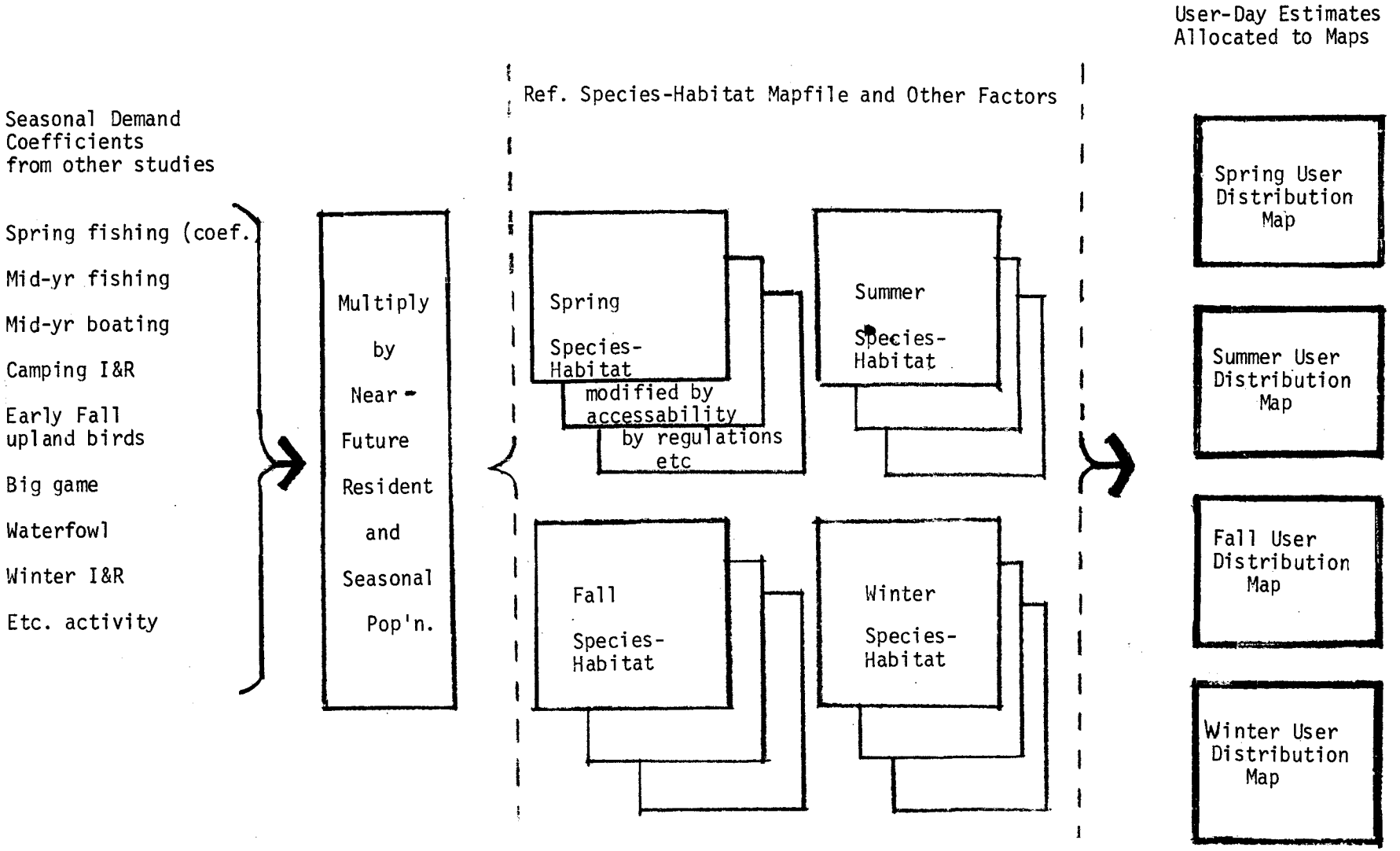
The seasonal population "demands" arising from both resident and outside population may be estimated, controlled, and distributed to specific species and seasonal habitats. The end products should be a linked set of seasonal maps, tying habitat maps with human population recreation demand. Further, these distribution maps can be interpreted into impact loads on critical areas, winter feeding grounds, low water locations, nesting areas, etc. The maps supplied by this module are evidently needed in: Refuge master planning, fisheries technical assistance to states and BIA, and Level B planning in large regions. See figure 6.4 for a descriptive flow chart of the Seasonal Population and Utilization of Fish & Wildlife Module.

6.6 Geographically Referenced FWS Land Ownership and Lease Data

6.6.1 Nature of Module

The Region Six Realty Office at Denver, Colorado is primarily a repository for deeds, easements and status (ownership, location, land use and acreages) of lands under FWS jurisdiction as well as potential purchases and easements. The information supplied by a

Figure 6.4 Seasonal Demand for and Utilization of Fish and Wildlife Resources



geographic information system would be applicable to FWS refuges, games ranges and the five million acres of wetland resources under easement programs or owned by FWS as part of the Wetland Preservation Program.

The data compilation module would consist of acquiring, indexing and storing data of FWS land. The following characteristics of land would be included:

1) Land Location Identifier
   Public Land Survey
   Township-Range-Section

2) Ownership Status
   FWS owned, fee acquired, under interagency ownership status, leased, development rights acquired, etc.

3) Acreage

4) Previous owners, or present leases

5) Management status of land

6) Wildlife Habitat Classification Code

7) Water rights, easements and other public or private claims on the land

8) Other parameters specific to the region

See figure 6.5 for a descriptive flow chart of the Geographic Referencing for Realty Operations Module.

6.7 Mineral Impact Module

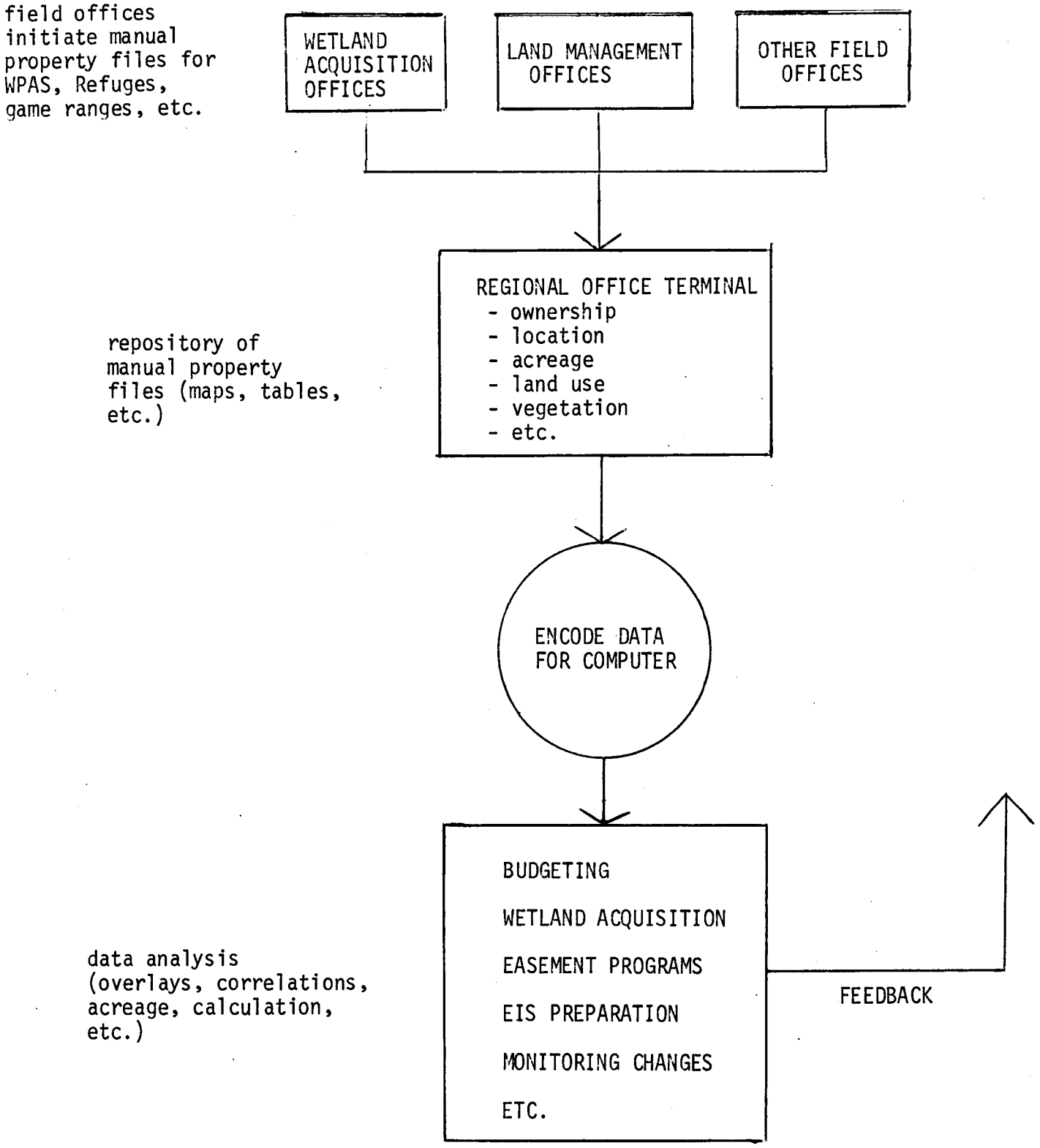
6.7.1 Nature of Module

This data compilation module would spatially identify the locations of primary and secondary energy mineral development activities including processing, and transmission of coal, uranium, geothermal or oil shale resources. It would use available maps and data which have been or are being developed by private, state or federal agencies or researchers. By integrating a land surface disturbance submodule with a water disturbance submodule, the most obvious co-incident primary effects of the mineral development activity can be displayed.

These submodules are described as follows:

1. A Land Surface Disturbance Submodule will develop a pattern of present and projected mining, processing, and transmission locations from coal strip mining, oil-shale mining, energy processing plants,

Figure 6.5 Geographic Referencing for Realty Module



energy transmission facilities, highlines, slurry pipelines, substations, etc.) plus the corridors of service roads and railroads. This pattern, and any alternatives, would be derived from federal and state offices, permit records and industry proposals where available;

The objective of this submodule would be to spatially locate different types of facilities. No interpretation or impacts would be made at this step.

2. A Water Disturbance Submodule would portray changes in the present and future water quantity and quality in a water basin subject to development of energy resources. Such models, being developed by the Instream Flow Group and others, would relate the present water allocation and use for domestic, industrial, agricultural and mining uses with the new requirements for proposed energy processing and transmission. It is also necessary to identify the water necessary for secondary activities, particularly urban and commercial water consumption for the total population resulting from the multiplier effects of the mining and energy industries. Water consumption coefficients for different activities would be applied to assumed activity volumes. Several changes of water to be traced would be:

   a. Changes in the total water quantity, depleting "in-stream flows" available for other uses (i.e., wildlife, agriculture, etc.);

   b. Changes in the water quality (temperature, chemical and physical characteristics);

   c. Changes in the location of water availability due to changed surface hydrology and ground water conditions.

3. A Composite Map would combine the land surface disturbance submodule and the water disturbance submodule. Several statements about the spatial patterns of these disturbances could be made, including:

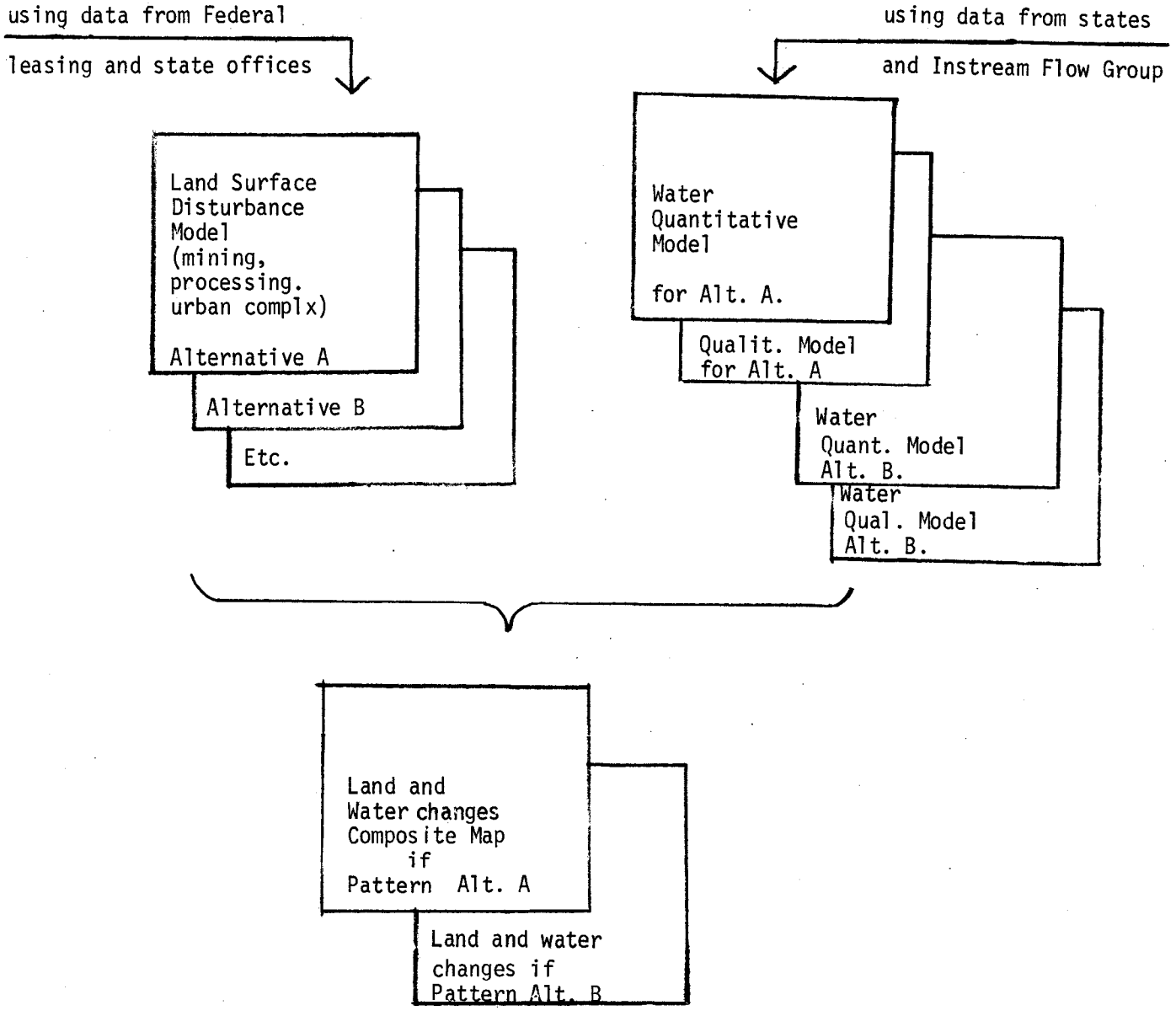
   1. The spatial pattern of overlapping activities (diffuse or concentrated);

   2. Alternative networks A,B, etc. of mining, processing, power plants, transportation and water supply could be overlayed under varying assumptions of industry development, and state or federal regulations.

The need for this module was indicated in our interviews with the Regional Office and the Billings Area Office, particularly in connection with the following projects:

1. The Wyoming Coal Coordination Program - Kent Keenlyne.

Figure 6.6 Mining Impact Module



2. Ecological Services Division of the Billings Area Office, in connection with:
   - Regional Powder River EIS Project
   - Area Wide Planning ;

3. Ecological Services Division of the Denver Regional Office, in the case of the Yampa River Study.

4. Various WELUT projects.

6.8 Ownership and Management Plans of Other Agencies Module

6.8.1 Nature of the Module

The Fish and Wildlife resources in the western U.S. are located not only on FWS land but also on lands owned or managed by several federal, state, and private agencies. Since each of these groups has their own plans and practices, the FWS groups need to become aware of the characteristics to include but not limited to:

1) U.S. Bureau of Land Management Unit Resource Analysis;

2) U.S. Bureau of Land Management Framework Plans;

3) U.S. Forest Service District and Forest Management Plans;

4) U.S. Bureau of Reclamation Development Plans;

5) State Fish and Game Wildlife Management Plans;

6) U.S. Bureau of Land Management Coal Lease Data;

7) U.S. Geological Survey Mineral Lease and Quality Data;

8) EPA's Water Quality Data in the Automated STORET system;

9) U.S. Geological Survey's Automated Water Quantity and Quality Data in WATSTOR files.

Each of these agencies' manual or automated geographically referenced files were likely created under a mandated program. As a result, the data collected and the manner in which the data are stored is dependent on the objectives of the program. Therefore, each data file will have its own special codes, formats, and geographic referencing system. The data compilation module would reformat these files to a common usable structure.

6.9 Cross-Tabulation of Data Compilation Modules (DCM's) vs. User Programs

To illustrate which modules were required by each user, a summary matrix was constructed. This matrix cross relates the seven compilation modules with the eight Billings Area Office users and the six Denver Regional Office users. (See Tables 6.1 and 6.2).

The purpose of this matrix was threefold:

1) To outline the diversity of uses of a particular DCM ;

2) To determine the variety of DCM's necessary to satisfy each user's program ;

3) To illustrate which DCM's will be most heavily used and thus should receive early treatment.

The matrix was completed by crosstabulating the detailed user needs from Report 1.1 with the data compilation modules.

By scanning the matrix (Table 3.1 and 3.2) by rows it can be seen that the Habitat-Species Distribution Module is most frequently used (10 users out of 14), and the Ownership and Management Plans of Other Agency data modules is often used (7 users out of 14 users). The Geographic Referencing for Realty Module is least frequently used (2 users out of 14). This analysis quickly illustrates which data compilation modules should receive early and intensive treatment.

(1) Note: The OBS Special Project Offices and WELUT projects were looked

TABLE 6.1 BILLINGS AREA OFFICES NEEDS FOR DATA COMPILATION MODULES

DATA COMPILATION MODULES	LAND MANAGEMENT	FISHERIES TECHNICAL ASSISTANCE	ENDANGERED SPECIES PROGRAM	COAL COORDINATION PROGRAMS	ES (ENERGY DEVELOPMENT)	ES (WATER RESOURCES DEVELOPMENT PLANNING)	ES (AREAWIDE PLANNING)	ES (10/404 PERMIT EVALUATIONS)
1. HABITAT ASSESSMENT	Refuge master planning requires habitat classification for several species groups and for assessing land for both livestock and wildlife grazing.		The recovery plan for the Northern Rocky Mountain Wolf requires determining the present and potential distribution and habitat of the NRMW and protecting or improving his habitat.	Wyoming long range coal planning, ecological zones mapping relies on habitat classification to develop impact maps. Wyoming high impact zones analysis requires mapping of major game species.	Powder River EIS requires major habitat type classification of some species.	HEP type analysis of major water development projects.	Macro habitat classification in the Level B studies.	Shorebirds and migratory bird component require riverine class.
2. STRUCTURAL, PHYSICAL & BIOLOGICAL STREAM SURVEY DATA	Refuge master planning and wetlands easement acquisition requires identification of stream alteration projects within or close to proposed refuges or wetland areas.	Fisheries stocking and hatchery programs require knowledge of structural, physical and biological stream data.			Powder River EIS requires stream survey data.	HEP requires information on stream characteristics.	Level B study requires macro stream classification.	Short and long term evaluation of hydrologic and biological effects of proposed changes.
3. ECONOMIC-DEMOGRAPHIC AND LAND USE CHANGES			Existing and Projected Land use and demographic patterns and densities are needed for NRMW Recovery Plan.	Wyoming high impact zones analysis requires labor, population and their demands.	Powder River EIS needs to assess impacts of secondary energy developments.	Water development projects need secondary impacts delineated (housing, services and roads).	Level B studies would benefit from economic,demographic, and land use projections.	Land use influences the rate and location of stream alterations.
4. SEASONAL POPULATION AND UTILIZATION OF F&W	Refuge master planning requires the projection of demand from seasonal population hunting and fishing on the refuge.			Secondary influences from mineral activities important to coal-coord program	Mining activities influence demands for hunting and fishing.	HEP type of demand estimation for monetary evaluation.	Changes in Recreation demands are important to Level B studies.	
5. GEOGRAPHIC REFERENCING FOR REALTY	The present realty system requires a more efficient method of indexing leases, fee lands and proposed leases.							
6. REGIONAL MINERAL RELATED ACTIVITY PATTERNS	Waterfowl acquisition activities need to know the long range mineral activities on an area before leasing.			Impact analysis and long range coal master plans requires best estimates of present and future mineral activities.	Powder River EIS requires best estimates of present and future mineral activities.			
7. OWNERSHIP & MANAGEMENT PLANS OF OTHER AGENCIES (SCS, BLM, FS, STATES, ETC.)	BLM, FS ownership & plans for adjoining lands important to CMR Master Planning.		Ownership and plans of other agencies influence recovery efforts of NRMW	BLM, FS, ownership & lease program plans crucial to coal location and impact analysis.	Powder River EIS requires knowledge of BLM, SCS, FS lands and plans.	Water Development Project Plans and Specifications.	Alternative Water Development Plans from Level B studies.	Location and characteristics of proposed stream alteration.

TABLE 6.2 REGION SIX OFFICES NEEDS FOR DATA COMPILATION MODULES

DATA COMPILATION MODULES	FEDERAL AID	YAMPA PROJECT	INTERPRETATION AND RECREATION	COLORADO BASIN PROJECT	REALTY	FISHERIES
1. HABITAT ASSESSMENT		Program requires habitat type and location maps for impact analysis.		Program requires habitat type and location maps for impact analysis.		Fisheries resources program at regional office requires fish habitat maps for overall regional program planning.
2. STRUCTURAL, PHYSICAL & BIOLOGICAL STREAM SURVEY DATA		Program requires data concerning water development projects and their impact on wildlife.		Program requires data concerning water development projects and their impact on wildlife.		
3. ECONOMIC-DEMOGRAPHIC AND LAND USE CHANGE		Program requires socio-economic population change data, and present and future land use changes.		Program requires socio-economic population change data.		
4. SEASONAL POPULATION AND UTILIZATION OF F&W		Program requires information about seasonal demands on terrestrial and acquatic wildlife.		Program requires information about seasonal demands on terrestrial and acquatic wildlife.		
5. GEOGRAPHIC REFERENCING FOR REALTY					Programs at regional office requires ownership information for all waterfowl production areas, game ranges and refuges.	
6. REGIONAL MINERAL RELATED ACTIVITY PATTERNS		Program requires location of existing and proposed mineral related activities.		Program requires location of existing and proposed mineral related activities.		
7. OWNERSHIP & MANAGEMENT PLANS OF OTHER AGENCIES (SCS, BLM, FS, STATES, ETC.)		Program requires ownership and management plans from federal and state agencies for the Yampa study area.		Program requires ownership and management plans from federal and state agencies for the Colorado Basin study area.	Programs at regional office requires data concerning location, ownership, acreages, land use, etc. for waterfowl production areas, game ranges and refuges.	

6.10 Summary of Data Needs by User Program

The use of the matrices in Tables 6.1 and 6.2 are limited to summary analysis only. Although several users will require the same Data Compilation Module (DCM) many users will request that the DCMs differ in the following areas:

1) different data resolutions or geographical accuracy ranging from a 2 1/2 acre cell resolution (1:10,000 scale map) necessary for site specific planning and facility location to 640 acre cell resolution (1:500,000 scale map) suitable for macro region wide planning of an entire river basin or state.

2) different data currency or updating frequency ranging from the requirement for 3-6 month currency for corporate mineral development plans to 10 year currency for soils and geologic map data.

3) different geographical coverage or extensiveness of the study area ranging from a 200 square mile study area around a small water development project to a 85,000 square mile study of the entire state of Wyoming.

4) differing data formats ranging from summary tabular reports to detailed 1:24,000 scale maps.

Due to these differing demands on a data compilation module, a summary of each user's specific data requirements is included in the following tables, one table for each user.

SUMMARY OF DATA NEEDS

TABLE 6.3
FOR BAO
ECOLOGICAL SERVICES
ENERGY DEVELOPMENT PLANNING

DATA COMPILATION MODULES NEEDED	POSSIBLE FORMAT OF SOURCES	AVERAGE REQUIRED DATA CURRENCY	AVERAGE SCALE OR RESOLUTION OF DATA	GEOGRAPHICAL COVERAGE OF DATA	ANTICIPATED SOURCE OF DATA
Ownership and Management Plans of Other Agencies	Map Tabular	Every 5 to 10 yrs.	1:250,000 1:500,000	Powder River Basin	BLM, USFS diverse (see form 3's)
Regional Mineral and Energy Related Activity Patterns	Map	Present plus 2-3 years projected in future	1:250,000	Powder River Basin	BLM Private Coal Companies, Wyoming State Geologist
Habitat-Species Assessment Module	Map	2-3 years	1:250,000	Powder River Basin	Wetlands Survey Color IR Interpretations Others

SUMMARY OF DATA NEEDS

TABLE 6.4
FOR BAO
ECOLOGICAL SERVICES
WATER DEVELOPMENT PLANNING

DATA COMPILATION MODULES NEEDED	POSSIBLE FORMAT OF SOURCES	AVERAGE REQUIRED DATA CURRENCY	AVERAGE SCALE OR RESOLUTION OF DATA	GEOGRAPHICAL COVERAGE OF DATA	ANTICIPATED SOURCE OF DATA
Habitat-Species Classification Module	Map	Frequent 1-2 years based on Land Use Change in area	Detailed 1:24,000 with 2 1/2-15 acre minimum polygon size	Area of influence Up and down Stream from development project 2,000-5,000 acres	USFS Wetlands Corps Varied (see form 3's)
Seasonal Demand for and Utilization of Fish and Wildlife Resources	Tabular & maps	Within 3-5 yrs.	MCD, CCD or County	States of Montana and Wyoming and large population centers	Bureau of Outdoor Recreation NPS State F & G (others, see form 3)
Socio-Economic and Gross Land Use Change	Tabular & mapped	Present plus projected 1980, 2000 yrs.	1:50,000 to 1:250,000	Area of up and down stream from development project 2,000-50,000 acres	Counties Private firms State engineer H.U.D.

SUMMARY OF DATA NEEDS

TABLE 6.5
FOR BAO
ECOLOGICAL SERVICES
SECTION 10/404 PERMIT EVALUATION

DATA COMPILATION MODULES NEEDED	POSSIBLE FORMAT OF SOURCES	AVERAGE REQUIRED DATA CURRENCY	AVERAGE SCALE OR RESOLUTION OF DATA	GEOGRAPHICAL COVERAGE OF DATA	ANTICIPATED SOURCES OF DATA
Habitat-Species Assessment Module	Tabular by river mile or map	Annual	1:10,000 to 1:24,000	All major streams in Montana & Wyoming	Montana Fish and Game Stream Survey USGS Dr. Allen Binns Wyoming Fish & Game
Stream Structural, Physical, and Biological Survey Data	Aerial photos, tabular by river mile, map	Every 1-3 yrs.	1:10,000 to 1:24,000 2 1/2 acre cells	All major streams in Montana and Wyoming	U.S. Army Corps of Engineers USGS Montana agencies

SUMMARY OF DATA NEEDS

TABLE 6.6
FOR BAO
ECOLOGICAL SERVICES
AREA-WIDE PLANNING

TA COMPILATION ODULES NEEDED	POSSIBLE FORMAT OF SOURCES	AVERAGE REQUIRED DATA CURRENCY	AVERAGE SCALE OR RESOLUTION OF DATA	GEOGRAPHICAL COVERAGE OF DATA	ANTICIPATED SOURCE OF DATA
Habitat-Species Assessment Module	Maps LANDSAT imagery	3-5 years	Very macro 1:250,000 to 1:500,000	Entire River Basin	Wetlands Color IR Others (see form 3's)
Stream Structural, Physical and Biological Survey Data	Map, tabular by river mile	3-5 years	Very macro 1:100,000 to 1:250,000	Entire River Basin	Varied (see form 3's)

SUMMARY OF DATA NEEDS

TABLE 6.7
FOR BILLINGS AREA OFFICE
LAND MANAGEMENT
REFUGE MASTER PLANNING

DATA COMPILATION MODULES NEEDED	POSSIBLE FORMAT OF SOURCES	AVERAGE REQUIRED DATA CURRENCY	AVERAGE SCALE OR RESOLUTION OF DATA	GEOGRAPHICAL COVERAGE OF DATA	ANTICIPATED SOURCE OF DATA
Habitat-Species Classification	Maps, Aerial Photos, USGS 7 1/2' Quads	2 - 5 years	from 1:10,000 to 1:50,000	Entire refuge plus adjoining lands 1,070,000 acres	OBS Wetlands Project Color InfraRed Imagery Interpreted
Structural, Physical and Biological Stream Survey Data	Tabular, by PLS, ID or river mile index or mapped	6 month to 1 year plus projected 1980	from 1:1000 to 1:24,000	River and stream bottoms within refuge	U.S. Army Corps of Engineers, - FWS manual files - New permit requests - Montana state automated stream survey system
Seasonal Population and Utilization of Fish and Wildlife	Tabular demand coefficients plus maps.	1 - 3 years plus 1980, 2000 projected	1:250,000 or to the CCD, MCD or counts	Entire refuge plus adjoining counties and major cities	State Fish & Game Surveys WELUT Recreational Demand Studies
Geographic Referencing for Realty	Tabular by PLS-ID or mapped	6 months to 1 year	from 1:10,000 to 1:24,000	Entire refuge plus adjoining lands within water drainages	FWS Realty Section
Regional Mineral and Energy Related Activity Patterns	Mapped	6 months to 1 year	from 1:24,000 to 1:50,000	Entire refuge plus lands adjoining major drainages in or out of refuge	BLM, USGS, various sources (see form 3'a)
Ownership and Management Plans of other Agencies	Mapped or tabular by PLS-ID	1 year to 3 years	from 1:24,000 to 1:50,000	Entire refuge plus lands adjoining major drainages in or out of refuge	BLM, BOR, CORPS, STATES U.S.F.S. (see form 3's)

SUMMARY OF DATA NEEDS

TABLE 6.8

FOR BAO

FISHERIES TECHNICAL ASSISTANCE

DATA COMPILATION MODULES NEEDED	POSSIBLE FORMAT OF SOURCES	AVERAGE REQUIRED DATA CURRENCY	AVERAGE SCALE OR RESOLUTION OF DATA	GEOGRAPHICAL COVERAGE OF DATA	ANTICIPATED SOURCE OF DATA
Stream, Structural, Physical, and Biological Survey Data	Tabular computerized	Seasonal updating	2 1/2 acres or 1:24,000	All streams which are stocked in Montana and Wyoming	FWS - Field Notes Montana F&G automated stream survey

SUMMARY OF DATA NEEDS

TABLE 6.9
FOR BAO
ENDANGERED SPECIES PROGRAM
RECOVERY PLAN FOR ROCKY MOUNTAIN WOLF

A COMPILATION DULES NEEDED	POSSIBLE FORMAT OF SOURCES	AVERAGE REQUIRED DATA CURRENCY	AVERAGE SCALE OR RESOLUTION OF DATA	GEOGRAPHICAL COVERAGE OF DATA	ANTICIPATED SOURCE OF DATA
bitat-Species sessment dule	Map	1 - 2 years	from 1:24,000 to 1:250,000	20,000 square miles in NW Wyoming and Western Montana	Various sources (see form 3)
nership and nagement Plan Other Agencies	Map	3 - 5 years	1:250,000	20,000 square miles of NW Wyoming and Western Montana	BLM, USFS, NPS, (see form 3's)

SUMMARY OF DATA NEEDS

TABLE 6.10
FOR WYOMING
COAL COORDINATION PROGRAM
HIGH IMPACT AREA DEFINITION

ATA COMPILATION MODULES NEEDED	POSSIBLE FORMAT OF SOURCES	AVERAGE REQUIRED DATA CURRENCY	AVERAGE SCALE OR RESOLUTION OF DATA	GEOGRAPHICAL COVERAGE OF DATA	ANTICIPATED SOURC OF DATA
Habitat-Species Classification Module	Map	3 - 5 years	1:50,000	Entire state of Wyoming	diverse (see form 3's)
Socio-Economic and Gross Land Use Change	Tabular	1975, 1980, 1990 2000, present plus projected	County or MCD, CCD if available	Entire state of Wyoming	Wyoming Department of Econ. Plg. and Develpment, Wyoming State Employment
Seasonal Demand for and Utilization of Fish and Wildlife Resources	Tabular demand coefficient plus maps	1-3 years plus 1980, 2000 projections	To the county or MCD	Entire state of Wyoming	State Fish and Game WELUT Recreational Demand Studies
Regional Mineral and Energy Related Activity Patterns	Mapped	3 months to 1 yr.	1:50,000	Entire state of Wyoming	BLM, USGS, State Geologist diverse (see form 3's)
Ownership and Management Plans of Other Agencies	Mapped & tabular	2 years	1:50,000	Entire state of Wyoming	BLM, BOR, USFS, diverse (see form 3's)

SUMMARY OF DATA NEEDS

TABLE 6.11
FOR DENVER
REGIONAL ECOLOGICAL SERVICES
YAMPA BASIN PROJECT

DATA COMPILATION MODULES NEEDED	POSSIBLE FORMAT OF SOURCES	AVERAGE REQUIRED DATA CURRENCY	AVERAGE SCALE OR RESOLUTION OF DATA	GEOGRAPHICAL COVERAGE OF DATA	ANTICIPATED SOURCE OF DATA
Habitat-Species Assessment	Map & Tabular	Unknown 3-5 years expected	30 acre resolution with 1 acre for same analyses	Yampa Basin 6718 square miles	CDOW, SCS, BLM, FS
Stream Structural, Physical, and Biological Survey	Map & Tabular	Unknown 3-5 years	30 acre resolution with 1 acre for same analyses	Yampa Basin 7300 square miles	BOR , USGS, BR, SCS, Federal Power Commission, FS, BLM
Socio-Economic and Gross Land Use Changes	Map & Tabular	Unknown 1970 and 1990 projects	30 acre resolution with 1 acre for same analyses	Yampa Basin 7300 square miles	County Planning Commission, SCS, FS, BLM, etc.
Seasonal Demand for and Utilization of Fish and Wildlife Resources	Map & Tabular	Unknown 3-4 years	30 acre resoltion with 1 acre for same analyses	Yampa Basin 7300 square miles	Bureau of Outdoor Recreation State G & F Others
Regional Mineral and Energy Development Activity Patterns	Map & Tabular	Unknown	30 acre resolution with 1 acre for same analyses	Yampa Basin 7300 square miles	USGS BLM, FEA Others
Ownership and Management Plans of Other Agencies	Map & Tabular	Unknown	30 acre resolution with 1 acre for same analyses	Yampa Basin 7300 square miles	BLM USFS Others

SUMMARY OF DATA NEEDS

TABLE 6.12
FOR DENVER REGIONAL OFFICE
ECOLOGICAL SERVICE
COLORADO BASIN PROJECT

DATA COMPILATION MODULES NEEDED	POSSIBLE FORMAT OF SOURCES	AVERAGE REQUIRED DATA CURRENCY	AVERAGE SCALE OR RESOLUTION OF DATA	GEOGRAPHICAL COVERAGE OF DATA	ANTICIPATED SOURCE OF DATA
Habitat-Species Assessment	Map	Unknown 3-5 years expected	1:24,000 to 1:50,000	Upper Colorado Basin	Unknown
Stream Structural, Physical, and Biological Survey	Map	Unknown 3-5 years	1:24,000 to 1:50,000	Upper Colorado Basin	BOR Federal Power Commission
Socio-Economic and Gross Land Use Changes	Map	Unknown 1970 and 1990 projects	1:24,000 to 1:50,000	Upper Colorado Basin	County Planning Commission varies (see form 3's)
Seasonal Demand for and Utilization of Fish and Wildlife Resources	Map	Unknown 3-4 years	1:24,000 to 1:50,000	Upper Colorado Basin	Bureau of Outdoor Recreation State G & F Others
Regional Mineral and Energy Development Activity Patterns	Map	Unknown	1:24,000 to 1:50,000	Upper Colorado Basin	USGS BLM Others
Ownership and Management Plans of Other Agencies	Map & Tabular	Unknown	1:24,000 to 1:50,000	Upper Colorado Basin	BLM USFS Others

GLOSSARY OF TERMS USED IN THIS REPORT

Geography:	Analysis of the patterns, structures, arrangements, and relationships of man's work on the surface of the earth (human geography) and of the patterns, structures and relationships of the earth itself (physical geography).
Spatial:	A key word used by geographers to indicate that they are interested in the relationships of phenomenon located in two and three dimensional space either in the abstract (the mathematics of point distributions) or on the ground (analysis of the habitats for various wildlife species).
Geographic Reference:	Explicit two and three dimensional locators of a phenomenon, such as the Latitude-Longitude coordinates of a water well site.
Geocode:	The process of attaching a geographic reference to a phenomenon, such as assigning a Latitude-Longitude to a water well site.
Spatial Analysis:	Techniques of analyzing geographically referenced data.
Spatial Display:	Methods of visually depicting geographically referenced data (contour maps or choropleth maps).
Data:	Data are raw numbers that convey little or no information in themselves.
Information:	Organization of data so that they are in a form useable for decision making.
System:	A system is a collection of entities and activities meaningfully connected and satisfactorily bounded which interact for a common purpose or purposes.
Information Systems:	When information or data resources are joined together in both a formal and informal manner, they are considered to have some organized structure. They become an information system to support the decision making processes of an organization.
Geographic Information System:	An information system that can <u>input</u>, <u>manipulate</u>, and <u>analyze</u> geographically referenced data in order to support the decision making processes of an organization.
Data Field:	A data field is a collection of data items within a record. For example, a data field called DATE

Record:	A record is a named collection of data fields. For example, the Joseph Smith may be composed of the data fields EDUCATION, DATE, AND OCCUPATION.
File:	A file is a named collection of occurrences of a given type of record. For example, a named file called EMPLOYEES may be composed of records for Joseph Smith, Peter Strong, and Harry Jones.
Data Base:	A data base is a collection of the occurrences of multiple record types, containing relationships between records, data fields and data items. For example, personnel files are a data base.
Data Base System:	An organized collection of data bases.
Hardware:	The actual physical equipment of a computer system (line printers, cabinets, teletypes, card readers, etc.).
Software:	A set of instructions, either man generated or machine generated, that tell the computer what to do.
Data Base Management System:	A set of software that allows the user to access and change data in a data base.
Data Input:	The process of transforming data from a manual form to a form that the computer can understand.

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4. Title and Subtitle User Needs Assessment for an Operational Geographic Information System			5. Report Date June 1977 6.
7. Author(s) Larry Salmen, George Nez, Carl Reed, John Hamill and James Gropper			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Information Systems Technical Laboratory Federation of Rocky Mountain States, Inc. One Drake Park, Suite 142, 333 W. Drake Road Fort Collins, Colorado 80521			10. Project/Task/Work Unit No. WELUT No. 002-76 11. Contract/Grant No. 14-16-0008-2155
12. Sponsoring Organization Name and Address Western Energy and Land Use Team, Office of Biological Services, U.S. Fish and Wildlife Service, Drake Creekside Building, 2625 Redwing Road, Fort Collins, Colorado 80521			13. Type of Report & Period Covered 14.

15. Supplementary Notes

Coal Funds; EPA-IAG-D5-E685; L.C. Number 77-82533.

16. Abstracts

This report documents the results of a five month survey of user needs for a geographic information system within Region 6 of the U.S. Fish & Wildlife Service (FWS). The overall project, of which this the report, is intended to develop an operational capability within the Fish & Wildlife Service to accept, store, manipulate and display spatially related data for use in a variety of FWS wildlife resource impact projects. This report covers three user groups. This task focused on the assessment of three groups of users: (1) the Denver Region 6 Offices of FWS, (2) the Billings Area Office within Region 6, and (3) the Office of Biological Services Special Projects. Some twenty individual user offices were interviewed with structured questionnaires and follow-up sessions to identify their legislative mandates, programs, tasks, work elements, and specific spatial data needs.

17. Key Words and Document Analysis. 17a. Descriptors

spatially related data
user needs assessment
user groups
wildlife resources
information retrieval systems
map indexing
map cataloging
geographic information systems
ecology
computer analysis

17b. Identifiers/Open-Ended Terms

U.S. Fish & Wildlife Service, Region 6
Western Energy and Land Use Team (WELUT)
Western United States
natural resource decision making

17c. COSATI Field/Group

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