IMPLEMENTATION OF AN INTEGRATED RESOURCE INFORMATION SYSTEM AND ITS APPLICATION IN THE MANAGEMENT OF FISH AND WILDLIFE RESOURCES IN ALASKA

William T. Brooks
U.S. Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, Alaska 99503

ABSTRACT

The U.S. Fish and Wildlife Service in Alaska is composed of several resource management and research components involved in the collection and analysis of data. The specific mission objectives of these component organizations vary from the definition and inventory of fish and wildlife resources to the assessment of environmental impacts and consequences given the implementation of proposed management actions. The data acquired through direct observation and monitoring of species, habitat surveys, remote sensing, and traditional mapping modes have been indexed, stored, referenced, and analyzed in both automated and non-automated "systems" for many years.

Increasingly complex issues and a significantly enlarged management role in a spatial sense have forced the evaluation and development of more expeditious and efficient means of managing these diverse data bases and providing a facility for information integration and analysis. Fiscal constraints have also created an environment condusive to the sharing of technical resources within the agency and among other natural resource management entities within Alaska. The design of the Integrated Resource Information System (IRIS) focuses on the use of remote micro-computers networked with a central mini-computer facility, utilizing hierarchical and relational data base Management Systems (DBMS), Geographic Information Systems (GIS), and customized applications. Hardware systems and software packages supporting local (tactical) reporting and data management needs are employed in field offices, while facilities and technical personnel required for the planning, design, and development of these systems andthe accomodation of regional management and policy (strategic) requirements are centrally located. Wherever possible, data entry andediting are accomodated using tactical facilities and abstracted or summarized data are incorporated into strategic data bases as required. System designs under the provisions of the IRIS concept make use of existing commercial software components (DBMS and GIS) to maximize standardization and minimize the necessity to develop software "in house".

Formal and informal contact is maintained with other resource management agencies (U.S. Bureau of Land Management, U.S. Forest Service, U.S. Geological Survey, the State of Alaska Department of Fish and Game, and the State of Alaska Department of Natural Resources for the purposes of sharing data, facilities, and expertise, reducing costs by minimizing redundant systems and facilities, and jointly developing systems to accomplish common mission objectives.

INTRODUCTION

The organization of government agencies is conceived out of political necessity and a recognition of professional, administrative, and technical disciplines. These organizational constraints often promote a parochial approach to the accomplishment of objectives, even in areas of mutual interest with other organizations. In 1980, with the passage of the Alaska National Interest Lands Conservation Act (ANILCA , jurisdiction over federal lands in Alaska was allocated to those Federal agencies in the Departments of Interior and Agriculture according to the traditional rules and conventions applied to the "lower 48". Lands conveyed to the State of Alaska under the provisions of the Alaska Statehood Act of 1959 are administered by similarly organized state agencies. This spatial approach to resource and land management and administvation has resulted in a complex array of invisible "boundaries" where the emphasis in management is based upon the interest, expertise, and political priorities of the administering agency. While the areas of jurisdiction reflect the nature and content of the resources they contain in a general sense, the potential to overlook causes and effects of actions taken in one area on another area exists. One example of this is the navigable waters issue, where state ownership of navigable waters has been mandated in areas otherwise administered by a federal agency.

Within the individual agencies themselves, organization reflects technical and scientific specializations. Within the U.S. Fish and Wildlife Service in Alaska, a multi-dimensional organization exists. Vertically, the Service is comprised of Wildlife Resources, Fishery Resources, Habitat Resources, and Research and Development programs. Horizontally, these programs have both regional and field station offices in Alaska. At the field station level, there are 16 Wildlife Refuges, 3 Fishery Field Stations, 3 Ecological Services Offices, and several Research Field Stations. While the mission objectives of these components vary according to program and locale, the overall goal of the Fish and Wildlife Service in Alaska is the effective management of Fish and Wildlife Resources. This includes the protection of endangered species and critical habitat, enforcement of federal fish and wildlife regulations, assessment of environmental impact and land use planning within the National Wildlife Refuge System in Alaska, and monitoring of various species. The most important tool in the attainment of that goal is information. This information must be objective, contextual, accurate, and timely. It must also be available to the decision makers.

BACKGROUND

With the passage of ANILCA by Congress in 1980, the U.S. Fish and Wildlife Service in Alaska was required to prepare a "Comprehensive Conservation Plan" for each of the 16 National Wildlife Refuges created at that time. Each of these plans must inventory and describe the natural resources and values within the refuge, the management programs to conserve those resources and values, the uses of the natural resources that are compatible with the purposes of the refuge, and the opportunities for fish and wildlife oriented recreation, research, and education within the refuge. In 1981, a regional computer facility was established. A Data General MV8000 minicomputer was acquired to support the data collection, storage,

analysis, and display requirments of the Refuge Planning Group. A Geographic Information System (GIS), consisting of the Analytical Mapping System (AMS), Map Overlay and Statistical System (MOSS), and GRID was implemented. AMS and MOSS were developed for the U.S. Fish and Wildlife Service by Autometric, Inc. several years earlier. GRID was acquired from the Environmental Systems Research Institute jointly with the State of Alaska Department of Fish and Game and modified for use on this system. Since the original development of this facility, other program needs in the collection, storage, analysis and evaluation of data have been addressed as well. In the process of evaluating these needs, it became evident that despite the diversity of data capture methods and objectives, common needs which transcended organizational constraints existed. With the evolution of computer technology, manifested in the availability of relatively inexpensive yet powerful microcomputers and the concept of distributed processing, the advantages of networking and systems integration became obvious.

In 1983, the Office of Information Resources Management was created in the Alaska Region of the U.S. Fish and Wildlife Service. The objectives of this office were to (1) provide operational support of the information needs of the Service in Alaska, (2) to manage and coordinate the use of the data processing, remote sensing, telecommunications, office automation, and library services, (3) to develop policies, standards and procedures for the application of these technologies to program needs, and (4) to promote further cost-effective means through networking, integration, and resource sharing with other agencies. Subsequent to the creation of that office, consideration was given to the variations in needs between programs and their hierarchical levels. The concept of "strategic" and "tactical" systems was used to provide a simple basis for the design of both software and hardware systems to meet these needs.

PHILOSOPHY

The Integrated Resource Information System (IRIS) is an invocation of a managerial philosophy in the design and implementation of systems rather than a design in itself. IRIS focuses on the use of (1) remote systems to support local data capture, edit, and reporting needs (2) a central facility for the support of data consolidation, integration, and (3) telecommunications networking between and among the local systems and the central system. It is recognized that this is not a necessarily unique approach. Centralized systems have long been criticized for insulating users from control over their processing environment, while decentralized systems create concern among higher level managers regarding security, data veracity and availability, and control of individual productivity. Distributed systems are advantageous in that, while users have direct control and access to local resources and data, data sharing and integration are facilitated through the use of telecommunications networks. Variations in the approach to networking are numerous. The most crucial elements in the design and development of a distributed system are (1) the standardization of data base elements, (2) quality control of local data, (3) minimization of unnecessary redundancy in hardware resources, (4) maintenance of software, and (5) systems compatability. The resolution of potential problems in these areas must be complete and absolute in order to assure a totally successful networking scheme.

In addition, networking provides for the maximization of resource utilization and economy of scale. In a time-sharing environment, common utilities may be simultaneously accessed by a wide variety of users on a single system. While there will be an increase in hardware utilization and requirements (processor cycles, storage, etc.), it must be realized that hardware components are becoming less expensive and software licensing and devlopment costs are rising rapidly. Unfortunately, any cost savings resulting from the use of timesharing in Alaska are more than offset by prohibitive communications costs. As a result, under the IRIS concept, data entry and editing are accomplished on remote facilities, or microcomputers. Interactive processes with the central facility using switched, or "dial-up", telecommunications are discouraged except for the transfer of data and information.

Another important consideration in the design of IRIS and its subsystems is the "contextuality" of information. Analysis of data for the purpose of obtaining information has as an inherent limitation the natural bias of the individual performing the analysis. A recognition and acceptance of this bias is an important design criterion. Unfortunately, the natural propensity for subjective evaluation cannot be easily documented or codified. Limiting the user's access to data for the purpose of controlling or limiting the subjective aspects of evaluation typically tend to only exacerbate the situation. For these reasons, the IRIS approach to data availability must be liberal. IRIS will provide raw data and tools for the analysis of that data, evaluation of the results, and depiction and reporting of information with minimum constraint upon the end user. If one were to enter a workshop and find piles of wood, woodworking tools, and instructions for the use of those tools, one would have the flexibility to build whatever one needed. Obviously, the quality and applicability of the finished product will be directly proportional to one's experience and expertise, but these limitations exist regardless of the approach taken. Care must be taken in this area not to create an environment where the use of the tools becomes more important than the quality of the results obtained. Therefore, significant emphasis will be placed on training and periodic evaluation of system resource utilization. The alternative is user dependance upon the limited resources and time constraints of a centralized support organization and facility. This facility must exist to accomodate the needs of strategic reporting and overall system design and maintenance, but the user must have the flexibility at the local, or tactical, level to provide for their own daily operational information needs.

Strategic information needs typically differ from tactical needs in both scope and detail. IRIS assumes that strategic information is a composite of the results of tactical evaluations. In order for the composite information to have credibility, certain constraints must be placed upon the tactical evaluation approach and format. This is, however, a management rather than a technical consideration. For this reason, IRIS employs a User Needs Analysis Document in the initial design and implementation of any system that ultimately affects more than one tactical location. In the performance of this User Needs Analysis, a representative of the user group is designated as the Project Manager and the Data Base Administrator. This individual must have the authority to make all decisions regarding the design of the tactical and strategic data bases, the rules which will comprise the supporting algorithms, and system

access and security. This individual must also accept the responsibility for the success or failure of the completed system. The duties of the Project Manager include consolidation and documentation of user design criteria and documentation of the completed system. The Office of Information Resources Management performs the analysis of user needs and recommends alternative approaches in terms of system development, aquisition of commercially available software, or use of existing facilities. The user makes the selection of the preferred alternative based upon time and fiscal constraints.

The availability of the composite data in the strategic data base is not a constraint upon the design and implementation of new systems. The primary reason for this is that there is not a single strategic data base, but several. These data bases will be linked indirectly by an internal bibliographic index system, or directory. Access to individual data bases is controlled by the intrinsic file access controls system of the regional computer, which can provide levels of access ranging from the ability to modify records to the ability only to read indirectly through intermediate processes. The use of temporary data bases consisting of the results of inquiries of several permanent data bases can be accomodated through the use of a commercially available Data Base Management System (DBMS). This DBMS, "INFO", also provides the necessary interface to the Geographic Information System for analysis and graphic representation.

In summary, the IRIS philosophy is that strategic reporting requirements may support the development or acquisition of tactical systems, but must not be the basis for their design. The tactical user typically has the responsibility for data entry and validation and must see direct results from their efforts in the accomplishment of their objectives.

IMPLEMENTATION

Fisheries Information Network

A subsystem of IRIS, the Fisheries Information Network (FIN), was selected as the pilot project using these design criteria. In 1984, three Data General 10SP microcomputer systems were acquired for the three Fishery Field stations. In general, the design of FIN requires a significant amount of detailed biologically oriented data, collected through sampling surveys, to be collected by the field stations. Analysis of the survey data will be performed at the local, or "tactical", level. Resultant statistics will be integrated from the three stations into a composite data base located on the regional, or "strategic", system. All data collection and editing will be done on the tactical systems. Once the data has been collected and edited and the local analysis is completed, the resultant information will be "uploaded" into the strategic data base. The strategic system will accomodate regional reporting and mapping needs while the more detailed data remains available to the field stations for local reporting and analysis requirements. The Project Manager for FIN determined that the regional, or strategic, data needs would be met as a result of the data collection and analysis performed at the field, or tactical, level. While all three of the field stations had some differences in their initial data elements definitions, subsequent discussions

resulted in a common design which met all of their needs. In Phase I of the implementation of FIN, the data collection and editing applications were written and installed on the tactical systems. Phase II will consist of the development and installation of the data analysis and reporting requirements of the tactical users. Phase III will consist of the implementation of the strategic data base and incorporation of the Geographic Information System capabilities into FIN at the strategic level. In this system, it was determined that it would not be cost effective to provide direct access to GIS capabilities at the tactical level at this time. This is due primarily to limitations in data communications facilities and the cost of GIS support hardware such as graphics terminals and plotters for those sites.

Wildlife and Habitat Information Systems

Over a period of several years, a number of small systems were developed to support the collection, editing, and reporting of information relative to the observations of a number of wildlife and waterfowl species. These systems were developed on an ad hoc basis with little or no consideration given to the desire to relate data from one system to another. This has resulted in redundancy, unnecessary modification to accomodate changes in minute reporting detail, and a lack of compatability. As previously discussed, a parochial approach to system development and data management will evolve without a mandate for standardization. In addition, this standard must result from a recognition on the part of the user that such an approach is the desireable alternative. Given limited resources for the development of new applications or modifications to existing systems, IRIS has provided a means for the consolidation of these smaller data bases using data base management technology that may not have been available when the original systems were implemented. As a result of this assimilation, certain analysis techniques have been made available to users and relationships between causes and effects which were not previously considered will result. For example, a consolidation of data regarding the location of marine birds and mammmals and other species would provide a basis for easily determining the potential impact of an oil spill or other contaminants if a common element for establishing that relationship existed. This would provide an opportunity to document relationships that were previously only speculative. While differences will exist in certain elements, it became obvious in the analysis process that there are many similarities among these smaller systems. The common element throughout these data bases is location, expressed in latitude and longitude, of observations and sitings. At present, it is planned to assimilate the data contained in these smaller systems into the Wildlife and Habitat Information Management System (WHIMS), which will be supported by an ARC/INFO, an integrated GIS/DBMS package developed by the Environmental Systems Research Institute (ESRI). While this system will remain resident on the regional computer system as a strategic application, data entry and editing will be accomodated tactically using portable microcomputers. Observation data will be recorded in the field and uploaded in either larger microcomputer systems or directly into the regional computer. Verification reports and plots will be generated by the strategic system and returned to the field biologists for review and correction.

Strategic Support System

The regional computer system is located in Anchorage, Alaska. It consists of a Data General MV8000 minicomputer. At present, this system is comprised of 6 megabytes of memory, 2 gigabytes of disk storage, and supports a network of 64 dedicated terminals and 8 switched telecommunications ports. Peripheral equipment includes a CALCOMP digital drum plotter, a Tektronix 4115B Color Graphics System, two digitizing stations, and several Tektronix graphics work stations. Supporting software packages include AMS/MOSS, ARC/INFO, DBMSII and INFOS (Data General Data Base Management Systems), and a number of custom applications developed for regional users to support administrative and resource management programs. Telecommunications applications for networking with tactical systems and the facilities of other agencies are also maintained.

Tactical Support Systems

In October, 1984, an additional 17 Data General 10SP microcomputer systems were acquired for the Wildlife Refuge Offices, Ecologocal Services Offices, and Research Stations. These systems will intially be used to provide word processing and generic spreadsheet and statistical capabilities. Support systems similar in concept to FIN will be implemented as they are developed. The Office of Information Resources Management in the Regional Office is in the process of acquiring additional commercially available software to support GIS needs on the tactical systems. As stated earlier, the primary obstacle to the effective implementation of GIS at the tactical level is the high cost of telecommunications. At present, Fish and Wildlife Service telecommunications facilities consist of the use of switched, or "dial-up" access, using 1200 Baud Racal-Vadic 3400 Series modems and commercial phone lines. Where available, the use of TYMENET and TELENET are encouraged for electronic mail and transfer of text. At present, these services are available only in Fairbanks, Juneau, and Anchorage. Stations located in other areas must use commercial long-distance carriers. By early 1985, those stations located in Fairbanks will be able to access the regional facility in Anchorage using a statistical multiplexer and high-speed data circuit under an arrangement with the Alaska State Office of the Bureau of Land Management. Other plans include development of similar resource sharing agreements with Federal and State agencies as well as the use of commercially available networks where cost-effective.

CONCLUSION

In the absence of a long term plan and design strategy, small, seemingly unrelated systems develop on an ad hoc basis. The concept of Information Resources Management imposes a requirement for system planning that transcends the traditional approaches to the acquisition of hardware to support "data" processing needs. There must be a recognition that data is a raw resource, expensive in its acquisition and, in some cases, non-renewable. As with any resource, consideration must be given to the maximization of its use and availability while protecting it from waste or loss. While there are obvious exceptions to a concept that all natural resource information must be available to anyone expressing an interest and having the resources to exploit it, there must be a recognition that we in government can no longer afford an approach that allows duplicity, redundancy, and parochialism in the management of natural resource information.