Evaluating Science in the National Park Service

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Preface

The following paper was written in 1977 when science program evaluation was considered a high priority item and plans were underway to establish formal evaluation procedures for the National Park Service on a Servicewide basis. Subsequent organizational and functional changes in the Washington Office negated these plans and the paper was set aside and essentially forgotten. It is resurrected here as originally written for what it is – an historical document. Although the concepts presented were conceived over a decade ago they appear to be just as viable today as they were when first written, and as such, may be of use to those persons wishing to scrutinize their own research program(s).

Introduction

The Chief Scientist of the National Park Service (NPS) is the principal assistant to the Director for science and technology. He is responsible for the overall guidance, policy formulation and program evaluation of the Servicewide science program. The program is regionalized so that each Regional Director exerts managerial control over science in his region. The Regional Chief Scientist is the principal assistant to the Regional Director and is responsible for the operational aspects and technical guidance for the program. This includes inhouse research conducted by Service scientists stationed in parks or universities and work contracted out to cooperating universities, etc.

Measuring the performance of such a diverse program requires a system of program evaluation in order to monitor program quality, adequacy and effectiveness. This involves scientific reviews by technically and/or administratively qualified and experienced scientists for determining program status and making recommendations for adjustments as required.

The establishment and conduct of these scientific reviews, the scheduling of site visits and the development of evaluation reports and recommendations become fairly routine once a system is established and fully operational. However, before implementing such a system the program in question must be examined to determine its component parts. Once identified they can serve as the program entities upon which evaluations are based.

Identifying these components and some obvious relationships between them is the subject of this paper.

Attributes of Mission Oriented Science

Mission oriented science concerns the conduct of research and related activities for the purpose of satisfying particular information requirements of management. This 'goal achievement' quality suggests that certain basic attributes may exist which would be common to mission oriented programs in general. These attributes are identified and defined as follows:

Planning—the identification of research needs which are based upon the specific information requirements of management.

Administration—the utilization of available manpower, funding and related administrative resources to develop, implement and operate an effective scientific research program.

Execution —the implementation and conduct of scientific investigations, utilizing existing administrative resources, for acquiring data to meet research needs.

Utilization—the development, reporting, systematizing and distribution of information resulting from research.

Integration—the policy implications of the management actions that are implied by the scientific research findings, depending on the degree to which the actions are consistent with existing policy.

Impact—the implementation and effectiveness of management actions which are initiated as a result of applying information from research findings.

Furthermore, a direct relationship appears to exist between these attributes and it can be represented graphically in a simple flow diagram (Fig. 1).

Components of the NPS Science Program

Assuming that these attributes are fundamentally common to mission oriented programs in general, they can be used as a basis for determining the composition of specific programs. An examination was made of the NPS science program utilizing these attributes to determine its composition preparatory to, and for the purpose of, developing a system of program evaluation. This examination revealed various program elements that could be classified under broad, subject categories corresponding to the attributes discussed above. These categories were identified as follows:

I Research Goals (Planning)
II Research Resources (Administration)
III Ongoing Research (Execution)
IV Research Application (Utilization)
V Policy Implications (Integration)
VI Management Actions (Impact)

The program elements, when classified under these categories, depict the composition of the NPS science program and form the basis for developing program evaluation guidelines.

Outline of Program Elements

The composition of the science program is readily discernible when the program elements (general and more specific) are presented by category in outline form:

The NPS Science Program

I. Research Goals (Planning)

A. **Identification of Descriptive Research Needs.**
An information base called the Resources Basic Inventory (RBI) is utilized for planning and managing park areas. It consists of the compilation of existing information and acquired new information to describe the present status of natural resources, historic resources and the social, economic and demographic characteristics of parks or potential park areas. (National Park Service 1975, p. II-1) These RBI needs must be identified for:

1. **Management Objectives**
Guidelines for developing the General Management Plan (defined under IA-3 below) and park operations (until plan is completed) which are consistent with NPS policies and purposes (National Park Service 1975, p. II-2).

2. **Outline of Planning Requirements**
   An information statement of the specific planning tasks needed to meet park management objectives which lists plans, related studies and information requirements.
3. **General Management Plan**
   A plan providing for the realization of park purpose, under applicable legislation and management policy, which defines long term park management objectives and provides the strategy for achievement (National Park Service 1975, p. II-2 thru 6).
4. **Specific Management Plans**
   Includes Resources Management Plans, Interpretive Plans and Visitor Use Plans (defined under IB-1, 2, 3 below).
5. **Environmental Impact Statements**
   Statements required for the environmental assessment of proposed management actions under the National Environmental Policy Act of 1969.
6. **Various Development and Management Actions**
   Other proposed actions that may come to need the benefit of an information base prior to implementation.

B. **Identification of Analytical Research Needs**

New information is required when existing information is insufficient for solving a resources management problem or making a management decision. These analytical research needs must be identified for the development of:

1. **Resources Management Plan**
   A natural resources studies and management plan for continual protection, management and maintenance of the natural resources to achieve the purpose and objectives of a park area and to appropriately regulate the effects of park use. It identifies and defines the equilibrium condition to be achieved and/or maintained regarding principal ecosystems and specifies actions including alternatives to achieve and or maintain that condition (National Park Service 1971, IV(5) p.1-2).
2. **Interpretive Plan**
   A plan for providing a program to communicate an appreciation of park resources and values, a basic understanding of forces shaping the environment, an awareness of the individual as part of the environment, and a human dependency upon and responsibility for environmental quality (National Park Service 1975, p. VII-2).
3. **Visitor Use Plan**
   A plan for the development and management of recreational activities which provides for appropriate visitor use and enjoyment without impairment to natural resources and opportunities for authorized activities with a minimum of direction consistent with visitor health, safety and resource protection (National Park Service 1971, V(1) p. 1-12).
4. **Contingency Plan**
   An informal, backup plan to accommodate special situations that might arise suddenly and that may require the expenditure of funds and assignment of manpower not covered in the above action plans.

II. Research Resources (Administration)

A. **Program Organization**

The organization of a program must fit the mission to be accomplished. The NPS must effectively utilize its own scientists and those of cooperating universities for accomplishing research goals. Therefore the program must be coordinated regarding:

1. **Science Offices/Personnel**

Science personnel should be in an appropriate organization scheme considering:

a. **Staffing requirements** to insure meeting program needs for inhouse performance of research and administration of contractual research.

b. **Role and function statements** to define the role and function of each organizational unit and each employee within that unit (National Park Service 1971, p. 2).

c. **Personal standards of performance** to describe the results to be expected and obtained when each employee satisfactorily performs his or her functions (National Park Service 1971, p. 2).

d. **Cooperation/coordination with related programs** as required to insure proper scientific assistance for the other programs being served.

2. **University Research Centers**

By means of cooperative agreements, centers of research are established whereby universities are utilized for acquiring data as an adjunct to research performed by NPS scientists duty stationed in parks and/or by contract with other government agencies. Coordination of inhouse capabilities with use of research centers must consider:

a. **University research programs** administered by the Regional Chief Scientists to provide assistance to parks in fulfilling their research needs in the context of overall regional priorities.

b. **Status of master memorandum of understanding** to insure that a valid agreement exists between NPS and the cooperating university for the work to be performed.

c. **Administration of current contracts** by the contracting officer's representative to insure that the terms of the contract are being met including adherence to the work plan upon which the contract is based.

d. **Annual cooperative review** by representatives of NPS and the cooperating university to insure that terms of the agreement are being met.

e. **Five-year termination/renewal review** to determine by scientific review the past performance of the university research center and to determine the adviseability of renewing the agreement for another 5 year period.

f. **Cooperation/coordination between region, university and the parks served** to insure that an appropriate relationship exists for meeting designated research goals.

B. **Program Development**

The operation of a program involves meeting certain administrative requirements in order to properly support program activities:

1. **Programming**
   The process of requesting adequate funds to meet research needs through the established programming procedures (Norwood 1974) considering:
   a. **Conformance to research goals** during the programming process to insure that approved priority needs are met.
   b. **Cooperation/coordination in program preparation** between science and programming offices to insure timely and accurate submission and consideration of requests in the programming cycle.
2. **Budget (Funding)**
   The funds available through the programming process for meeting research needs considering:
   a. **Allotment of funds** in a timely manner.
   b. **Identification of funds** throughout the allocation process for clear records on how the funds are being disbursed and for what purpose.
3. **Finance (Accounting)**
   The process of recording actual expenditures of science funds as opposed to those which were allotted considering:
   a. **Monitoring of research expenditures** in a manner that insures an accurate accounting at all program levels.
   b. **Procedures for financial reporting,** which accurately report expenditures appropriate program levels in a timely manner.
4. **Contracting**
   The act of having research performed by outside (of NPS) sources considering:
   a. **Conformance to rules/regulations** regarding negotiation, sole source requirements, etc. (Tidwell and Metrinko 1975).
   b. **Timeliness of issuing contracts** once funds are allotted, to insure meeting research needs promptly.
   c. **Monitoring of contracts** by the contracting officer's representative to insure conformance quality of work and adherence to work plan (contract objectives).
5. **Personnel**
   The placement of well qualified people in available positions to meet science program needs considering:
   a. **Manpower requirements** adequate to meet staffing needs.
   b. **Position classification** in accordance with the demands of the job and qualifications of incumbent scientists.
   c. **Recruitment procedures** that provide proper review of applicant qualifications by scientists before positions are filled.

C. **Program Quality Control**
The performance of individual scientists and the conduct of scientific research and related activities must be systematically monitored through:
1. **Research Grade Evaluation**
   The measurement of research personnel performance utilizing the generally accepted guidelines (Civil Service Commission, 1964; and Walker 1973) including:
   a. **Establishment/utilization of scientific peer review system** to properly perform research grade evaluation on scientific personnel and positions on a routine basis.

b. **Directory of positions/personnel** to insure proper monitoring of all science personnel and positions for use in the continual research grade evaluation process and for overseeing the filling of vacancies with qualified applicants.

c. **Schedule of reviews** to provide research grade evaluation for each research scientist/position on a routine basis.

d. **Implementation of review recommendations** by the responsible office to provide research scientist with appropriate job status or to grade the position accordingly.

e. **Utilization of reviews in recruitment** for filling vacancies to insure that qualified applicants are considered for the job.

2. **Science Program Evaluation**

The monitoring of the conduct of the science program to insure the quality, adequacy and effectiveness of scientific research and related activities in meeting the needs of park management by:

a. **Development/use of scientific peer review system** to evaluate science program status (as per elements in this outline) through site visits on a routine basis.

b. **Directory of sites (programs)** to be evaluated in order to insure the review of all significant programs on a continual basis.

c. **Schedule of site visits** by peer review panels to provide science program evaluation on a routine basis.

d. **Implementation of peer review recommendations** by the responsible office to insure the highest quality of program performance.

3. **Research Review**

The measurement of the excellence of research which is conducted to meet research goals considering:

a. **Degree natural science studies at standard** regarding the classification, inventory and analysis of the natural resources as prescribed by NPS Standards (National Park Service 1971, IV(S) p. 20-4).

b. **Conformance to science policy** of ongoing research to insure meeting the science mission of providing information for the decision making process (National Park Service 1975 p. IV-2; and Walker 1974c).

D. **Program Guidelines**

Appropriate procedures in the form of handbooks (National Park Service 1965), directives, etc., must be adhered to for uniformity of conducting the various aspects of the science program considering:

1. **Conformity to Accepted Procedures**

The utilization of currently accepted guidelines in the day to day operation of various aspects of the science program.

2. **Monitoring of Performance**

The systematic review by the responsible science administrators of the implementation and use of program guidelines to assure the uniformity of operation on a Servicewide basis.

III. Ongoing Research (Execution)

A. **Identification of Present Needs**

The determination as to whether or not existing research activities properly conform to present management problems, as expressed in existing action plans or not, such that the research needs are being implemented for:

1. **General Management/Operations**
   The studies required for solution of current management/operations problems.
2. **Planning, Design, Construction**
   The studies required for planning design and construction when environmental matters are involved.
3. **Natural Resources Management**
   The studies required to support present natural resources management needs.
4. **Natural History Interpretation/Education**
   The studies required for supporting the present natural history interpretation and environmental education program needs.
5. **Environmental Monitoring**
   The base line studies required to determine existing environmental conditions and the measurement of changes periodically to determine future trends.

B. **Adequacy of Research**

In the context of ongoing research (above) a determination must be made on its adequacy as judged in its relation to:

1. **Objectives**
   The purpose of each study must be properly defined in accordance with the problem to be solved.
2. **Study Design**
   The design of each study must meet the needs of the work to be accomplished by insuring the adequacy of:
   a. **Methods** for conducting the study.
   b. **Logistics** for coordinating the use of manpower and equipment to properly conduct the study.
   c. **Equipment** for making the necessary measurements, etc.
3. **Results**
   The adequacy of study results must be determined in relation to:
   a. **Data acquisition** being accomplished in an efficient and appropriate manner.
   b. **Data analysis** being conducted with accuracy and objectivity.
   c. **Conclusions** being drawn from adequate data of sufficient quality in an objective manner.
4. **Recommendations**
   The information derived from new research data must be placed in useable form for consideration by management during the decision making process regarding:
   a. **Alternative actions** that can be taken to alleviate the management problem under consideration.
   b. **Recommended action** that is proposed as the best alternative action for management to pursue, based on objective scientific review of the situation in question.

IV. Research Application (Utilization)

A. **Reporting of Research Findings**

The information derived from new research data must be reported in a timely manner by various means:

1. **Oral Reports**

   An immediate form of communication for alerting the manager and other scientists of new information as soon after its derivation from research data as possible.

2. **Preliminary Written Progress Reports**

   The presentation in some printed form of tentative research findings as a follow-up to the oral report (above).

3. **Annual Progress Reports**

   The yearly compilation, by the Regional Chief Scientists, of status reports on ongoing research and summaries of work completed in park areas during the calendar year including work funded by NPS and other sources.

4. **Publication in Scientific Literature**

   The making available of new information in its formal, printed form through the appropriate scientific journals, etc.

5. **Distribution of Unpublished Reports and Publications**

   The making of new information available in various forms of printed documents including:

   a. **Inhouse** distribution to NPS managers and scientists for information and/or use.

   b. **Other** distribution to outside managers and scientists for information and/or use.

B. **Information Management Systems**

In order to provide for intensive and widespread use of research findings by scientists and managers alike the data must become part of a computerized information system(s) for storage, retrieval, analysis and manipulation considering:

1. **Standardization of Data Elements**

   The utilization of appropriate Servicewide standards on data gathering, format and treatment thereof to insure the uniformity of inputed data and its usability regardless of where or why it is collected.

2. **Ecological and Environmental Management Information System**

   In order to be effective, this system for handling information (U.S. Congress H.R. 1972; and National Park Service 1972) must have the benefit of continual input of new data from various sources in a standardized form and provide outputs for:

   a. **Research** to determine what information already exists on certain subjects before recommending actual research needs for any given management problem.

   b. **Natural resources management** to determine what information is available before taking specific management actions and/or developing management programs.

   c. **Natural history interpretation/education** to develop accurate and up-to-date informational programs.

   d. **Planning, design and construction** to use in the planning

process and follow-up stages of park development.

C. **Information Exchange**

The concept of exchanging information in various forms with cooperating organizations, including the interchange of knowledge through computerized information systems including:

1. **Smithsonian Science Information Exchange**

   A clearinghouse for scientific information on current research actually in progress, involving government and non-government agencies with major research programs which furnish timely information on current research programs and projects.

2. **Cooperating Federal, State and Local Agencies**

   All research findings of the NPS should be readily available to other agencies for their information and use and vice versa.

3. **Cooperating Universities**

   Because the NPS relies heavily on cooperating universities for acquiring research data there must be free and efficient exchange to support NPS research and management programs.

4. **Cooperating Countries**

   As with domestic agencies, the NPS should freely exchange information in its relationship with foreign countries (Russia, Spain, Mexico, Australia, Japan, and Canada) regarding research on and management of natural areas, etc.

V. Policy Implications (Integration)

A. **Status of Management Actions which Research Findings Imply**

The purpose of a mission oriented science program is to provide information for use in the decision making process. The decision on a proper course of actions, based on the specific information provided, must be made in light of existing policy allowing:

1. **Management Acceptance and Implementation if Implied actions are Consistent with Existing Policy**

   No conflict exists if management actions which the research findings imply are consistent with existing policy, thus allowing the actions to be accepted and implemented by management, or

2. **Rejection and/or Alternative (below) if Implied Actions are Inconsistent with Policy**

   A conflict exists if management actions which the research findings imply are inconsistent with existing policy, causing the implied actions to be summarily rejected or an alternative taken.

B. **Analysis/Status of Policy if Implied Actions are Inconsistent with Existing Policy**

If management actions which research findings imply are inconsistent with existing policy and the implied actions are not summarily rejected then an analysis of the existing policy is required, leading to one of the following alternatives:

1. **Suspension of Existing Policy for Implementation of an Implied Management Action (when warranted)**

   Depending on the situation (political, etc.) the existing policy may have to be suspended so that the implied management action can be

implemented.

2. **Modification of Existing Policy to Accommodate Implied Actions**
   The situation may be such that a simple modification of existing policy may be desirable in order to accommodate the implied management action.
3. **Formulation of New Policy (if required)**
   If neither a suspension or modification of existing policy is acceptable then the remaining alternative is to abolish the existing policy and formulate new policy in order to accommodate the management actions which the new research findings imply.

VI. Management Actions (Impact)

A. **Implementation of Management Plans**
   Basic to the proper management of natural area parks is the implementation of action plans that institute management programs and provide for the identification, programming and budgeting for research needs through:
   1. **General Management Plans]**
      (See under IA3 above)
   2. **Resources Management Plans**
      (See under IB1 above)
   3. **Interpretive Plans**
      (See under IB2 above)
   4. **Visitor Use Plans**
      (See under IB3 above)

B. **Effectiveness of Management Programs**
   The impact of research findings on management of the natural resources of park areas can be determined by measuring the effectiveness of the programs that result from implementation of the management plans by considering:
   1. **Degree Natural Resources Management at Standard**
      The adequacy of management of the natural resources of park areas should be periodically determined with regard to (1) implementation of management plans, (2) maintaining an alert on threats to ecosystems, (3) encouragement of resource studies by outside scientists, (4) implementation of regional planning and wildlife management, (5) public awareness of NPS objectives for resources management, and (6) exercising an overview as to condition and effectiveness of the management of the natural resources as prescribed by NPS standards. (National Park Service 1971, IV(5) p. 1-2).
   2. **Conformance to Management Policies**
      The adherence to management policies with regard to preservation of heritage, resources management, park use, etc. in accordance with NPS Management Policies (National Park Service 1975).

C. **Updating/Development of Management Plans**
   Based on present resource problems and environmental conditions of natural area parks the various existing action plans must be updated periodically, and/or new plans developed for new areas, to insure proper management planning and to allow for implementation of proper management programs considering:

1. **Identification of Management Problems/Actions**
   The best professional advice available from within and/or without the NPS should be sought for the identification of resources management problems and courses of actions to be taken for preserving, maintaining and restoring natural resources.
2. **Determination of Need for Research**
   It must be determined if the management problems identified can be solved through use of existing information, whether research is required to obtain new information, or a combination of both. If new research is required then these needs must be specifically identified and overall research goals formulated for achieving these needs.

Discussion

Thus, various elements of the NPS science program have been identified and classified under subject categories that correspond to the six suggested attributes of mission oriented science. These categories of program elements have the same relationship to one another as the attributes of mission oriented science they represent (Fig. 2).

Other properties of the NPS science program are revealed when certain combinations of categories are made (Fig. 2). Combined, the categories of Research Goals, Research Resources and Ongoing Research represent program elements involving efforts that lead up to and include making scientific information available. These then represent the "input" aspects of the science program. Similarly, the combined categories of Research Application, Policy Implication and Management Actions represent program elements involving efforts toward application of the information by management. These represent the "output" aspects of the program.

The overall effectiveness of the science program not only depends on the quality and adequacy of the data being acquired (input) but also on how the information derived from this data is used (output), or influences, the decision making process of management. Furthermore, there must be proper feedback back into the science planning process to keep the whole program tuned to current management needs as time passes. This interdependence of deriving information, its use, and the feedback of results from management actions must be fully understood by managers and scientists alike. Otherwise, an organization's scientific efforts will not be able to serve the best interests of the overall mission.

Summary

Basic attributes of mission oriented science were suggested and defined during examination of the NPS science program to determine its composition. The examination resulted in the identification of various program elements, which can be classified under broad subject matter categories that correspond to these attributes. These results are presented in an annotated outline, which depicts the composition of the program and

which can serve as guidelines during the process of program evaluation. Relationships between subject categories and the program elements they represent also are explored.

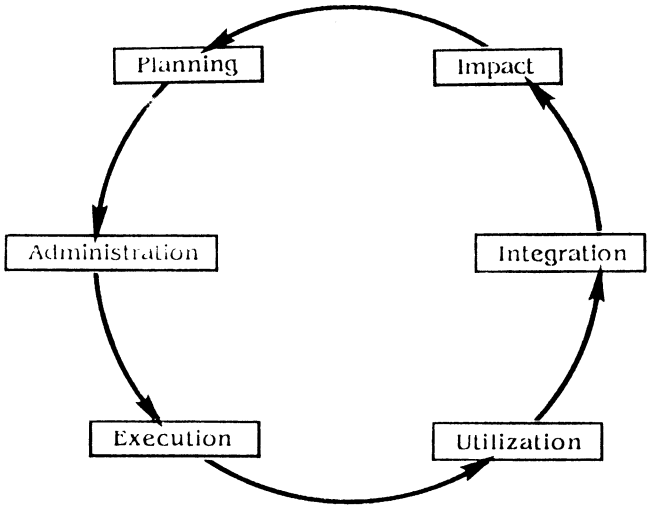

Figure 1. The relationships between the basic attributes of mission oriented science.

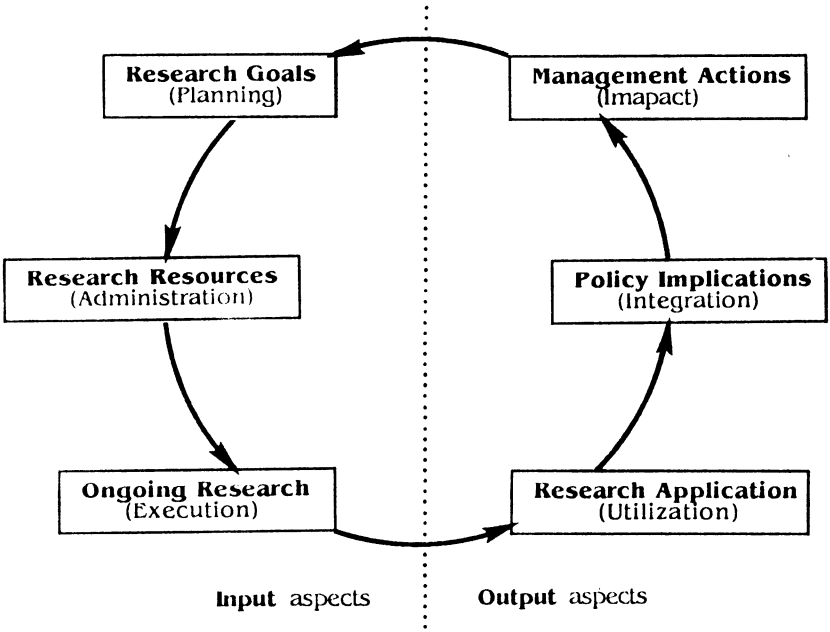

Figure 2. The relationships between the categories of program elements which comprise the National Park Service science program.