

**A FISHERIES AND WILDLIFE RESOURCE INDICATOR SYSTEM
FOR USE IN NATURAL RESOURCE MANAGEMENT**

by

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(ABSTRACT)

The development of a fisheries and wildlife indicator system is described. The system is intended to serve as a planning and policymaking aid for state fisheries and wildlife agencies and to enhance communications between state agencies and the public. The conceptual basis for the indicator system derives from the field of social indicators research and rests on the premise that explicit decisionmaking methods are more desirable than intuition and subjective methods.

Four major steps were involved in developing the fisheries and wildlife indicator system. The first step was assessing the current availability of resource information and involved analyzing state fisheries and wildlife agency annual reports. Administrative information was emphasized in reports over fisheries and wildlife resources and their use. States rarely reported trend statistics that allow comparisons over time to be made. Reports contained a mixture of quantitative and qualitative information, but contained few tables and graphs compared to the amount of text. Assessing the type, quality, and quantity of performance information currently available laid the base for subsequent work on the indicator system.

The second step was developing a comprehensive classification framework representing all aspects of the fisheries and wildlife resource. The framework, a 16-cell matrix including the resource categories of People, Populations, Habitat, and Administration, and the resource components of Inputs, Processes, Outputs, and Impacts, contained 82 separate resource characteristics representing the universe of concerns and responsibilities faced in state-level fisheries and wildlife management.

The third step was identifying indicators representative of each characteristic in the framework. Through an extensive analysis of fisheries and wildlife literature, agency documents, and social assessment literature, 377 indicators were identified. Based on appropriateness and availability of each indicator, 242 indicators were recommended for monitoring by state fisheries and wildlife agencies.

The last step in the process was describing the use of the fisheries and wildlife indicator system, how the system can fit into an agency's administrative structure and planning programs, and how its use may affect the future of fisheries and wildlife management.

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TABLE OF CONTENTS

Chapter 1: Introduction	1
What an indicator system can and cannot do	3
Influencing the thought process	5
Social indicators as an analogy	8
Statement of objectives	11
Chapter 2: Status of state communications	15
Methods	16
Results	19
Category comparisons	20
Information format	26
Budget and group comparisons	27
State comparisons	27
Discussion and recommendations	30
Chapter 3: Conceptual framework	35
Methods	39
Results	44
The fisheries and wildlife resource framework	55
Discussion	63
Chapter 4: Fisheries and wildlife indicators	65
Methods	67

Results and discussion	71
Matrix cell and indicator characteristics	74
Recommended indicators	116
Chapter 5: Discussion	125
Using the system	125
General implications	133
Implementation concerns	139
The next step	142
Literature Cited	146
Appendix A. List of Fisheries and Wildlife Indicators	166
1A: Inputs-People	167
1A-1: Demand: Quantity	167
1A-2: User Characteristics	170
1A-3: User Expectations	173
1A-4: Demand: Type of Experience	174
1A-5: Costs to Users	176
2A: Processes-People	178
2A-1: Education Activities	178
2A-2: Information to Users	180
2A-3: Providing Access	184
2A-4: Landowner Assistance	187
2A-5: Public Input Opportunities	189
2A-6: Law Enforcement	190

2A-7: Research: People	194
3A: Outputs-People	197
3A-1: Recreation Opportunities: Quantity	197
3A-2: Consumptive Use: Quantity	199
3A-3: User Knowledge/Awareness	203
3A-4: Recreation Opportunities: Type	207
3A-5: Consumptive Use: Type	208
3A-6: Nonconsumptive Use: Quantity	209
4A: Impacts-People	213
4A-1: Economic Influences	213
4A-2: Agency Perception	215
4A-3: Organized Club Affiliation	218
4A-4: Personal Benefits	219
4A-5: Societal Benefits	220
4A-6: User Conflicts.	222
1B: Inputs-Populations	224
1B-1: Populations: Quantity	224
1B-2: Populations: Requirements	225
1B-3: Populations: Distributions	227
1B-4: Populations: Type	229
2B: Processes-Populations	231
2B-1: Research: Populations	231
2B-2: Population Manipulation	232
2B-3: Stocking	234
2B-4: Damage/Depredation Control	237
2B-5: Species Introductions	239

2B-6: Animal Rehabilitation	241
3B: Outputs-Populations	243
3B-1: Harvest: Quantity	243
3B-2: Harvest: Type	246
3B-3: Populations: Quantity	248
3B-4: Research Results: Populations	252
3B-5: Populations: Type	254
4B: Populations-Impacts	255
4B-1: Damage/Depredation	255
4B-2: Threatened/Endangered Species	256
4B-3: Resource Utilization	257
4B-4: Effects on Unmanaged Species	259
4B-5: Wildlife Hazards	260
1C: Inputs-Habitat	262
1C-1: Holdings: Land	262
1C-2: Holdings: Water	263
1C-3: Water Quality	265
1C-4: Air Quality	268
2C: Processes-Habitat	270
2C-1: Habitat Acquisitions	270
2C-2: Research: Habitat	271
2C-3: Habitat Manipulation	272
2C-4: Habitat Conversion	274
2C-5: Pollution	276
3C: Outputs-Habitat	279
3C-1: Habitat: Quantity	279

3C-2:	Research Results: Habitat	281
3C-3:	Habitat Types	283
3C-4:	Reserves: Quantity	284
3C-5:	Reserves: Type	286
3C-6:	Habitat Quality	287
4C:	Impacts-Habitat	290
4C-1:	Preservation	290
4C-2:	Ecosystem Values	293
4C-3:	Scientific Studies	294
4C-4:	Environmental Impacts	295
1D:	Inputs-Administration	298
1D-1:	Revenue	298
1D-2:	Legislation	301
1D-3:	Holdings: Facilities	302
1D-4:	Personnel: Quantity	303
1D-5:	Personnel: Qualifications	304
2D:	Processes-Administration	306
2D-1:	Interagency Cooperation	306
2D-2:	Planning	308
2D-3:	Personnel: Training	309
2D-4:	Expenditures	310
2D-5:	Data Processing	311
2D-6:	Rules/Regulations	312
3D:	Ouputs-Administration	315
3D-1:	Land Available for Recreation	315
3D-2:	Articles/Reports	317

3D-3: Multiple Use of Holdings	318
3D-4: Personnel: Productivity	319
3D-5: Personnel: Safety	322
4D: Impacts-Administration	324
4D-1: Personnel: Morale	324
4D-2: Use of Agency Reports	325
4D-3: Political Influence	326
Vita	328

LIST OF ILLUSTRATIONS

Figure 1. Matrix of modes of thought (after Hammond 1978). . . . 6

Figure 2. Flow chart of procedures. 13

Figure 3. Results of cluster analysis. 29

Figure 4. Resource matrix skeleton. 37

Figure 5. Diminishing returns method. 46

Figure 6. Indicator identification process. 66

Figure 7. Example of indicator presentation. 136

LIST OF TABLES

Table 1. Information categories for content analysis.	18
Table 2. Content group characteristics for all states.	21
Table 3. Characteristics of frequently reported categories.	25
Table 4. Budget and reporting correlations.	28
Table 5. Literature sources for resource framework.	40
Table 6. Number of resource characteristics from each source.	47
Table 7. All resource characteristics identified.	49
Table 8. Characteristic reporting frequencies.	53
Table 9. Fisheries and wildlife resource framework matrix.	56
Table 10. Recent journals searched for indicators.	68
Table 11. Abstracts and indexes searched for indicator literature.	69
Table 12. Number of indicators identified for each characteristic.	73
Table 13. Indicators cited in source type 1.	75
Table 14. Appropriate, available indicators by resource component.	77
Table 15. Appropriate, available indicators by characteristic.	78
Table 16. Appropriate, available indicators by cell.	79
Table 17. Cell 1A indicators master list.	81
Table 18. Cell 2A indicators master list.	84
Table 19. Cell 3A indicators master list.	88
Table 20. Cell 4A indicators master list.	91
Table 21. Cell 1B indicators master list.	94
Table 22. Cell 2B indicators master list.	96
Table 23. Cell 3B indicators master list.	98
Table 24. Cell 4B indicators master list.	101

Table 25. Cell 1C indicators master list.	102
Table 26. Cell 2C indicators master list.	105
Table 27. Cell 3C indicators master list.	107
Table 28. Cell 4C indicators master list.	110
Table 29. Cell 1D indicators master list.	112
Table 30. Cell 2D indicators master list.	114
Table 31. Cell 3D indicators master list.	117
Table 32. Cell 4D indicators master list.	119
Table 33. Number of recommended indicators per cell.	121

CHAPTER 1: INTRODUCTION

In this dissertation, I describe my work developing a fisheries and wildlife indicator system. The indicator system is intended to serve as a planning and policymaking aid for state fisheries and wildlife agencies and to enhance communications between these agencies and the public. The impetus for developing this system came from recognizing several needs of state agencies that are currently met partially or not at all.

Fisheries and wildlife management agencies provide public goods and services (Driver 1985) and generally are supported by public revenues. Fisheries and wildlife managers are accountable to the public and are influenced by public attitudes. As public resources have become more scarce, the need for accountability has increased (Driver and Rosenthal 1982, Goodstein et al. 1982). Using the fisheries and wildlife indicator system can help meet this responsibility by providing the public with a regular account of management activities and outcomes.

New laws have broadened the responsibilities of fisheries and wildlife managers. They now oversee endangered species protection and recovery, environmental impact assessment, and non-game programs in addition to their traditional focus on consumptive wildlife uses (Bean 1983). Critics have called for managers to assess the results of management efforts in terms of public response and human benefits (e.g., Bailey 1982). Managers, however, are often perceived as being heavily oriented toward concerns of yield rather than the full range of responsibilities demanded by the public (Bennett et al. 1978).

One reason for this perception is that few methods now exist for monitoring and evaluating the multiple demands upon and responsibilities of fisheries and wildlife agencies. Applegate and Witter (1984) recognized the need to be able to communicate management accomplishments and failures to decisionmakers, managers, and the public. Communication becomes even more important as conflicts between human uses of the resource increase, and as the wildlife clientele grows and changes its desires (Kellert and Brown 1985). Providing timely and relevant information about resource management activities is critical to assuring that the public will have the ability to understand decisions made by resource managers and administrators. Providing such information is a necessary function of a government agency (Way 1983).

The need for communication within an agency is also apparent. Management by objective (MBO) has been embraced by many wildlife agencies (Strickland 1985). This management system requires that all factors involved in resource management be identifiable and readily measured (Gate et al. n.d.). At least 38 state agencies are involved in some type of resource planning programs (Wildlife Management Institute 1977). Twenty-one states have or are developing integrated planned management systems which allow administrators to coordinate all agency programs (Organization of Wildlife Planners 1985). As states move toward using comprehensive planning programs to guide their operations, management inputs, activities, and outputs need to be defined (Driver 1985). Without an accurate statement of desired, quantified agency outputs, it is difficult to evaluate whether an agency has accomplished its objectives (Kansas Fish and Game Commission 1985).

Benefits of enhanced communications regarding management activities and outputs would accrue not only to agency personnel and the general public, but also to high-level decisionmakers and administrators, special interest groups, and the scientific community (Thomas 1972). Trends in management activities and results could be used to help establish research needs and priorities. The efforts of special interest groups would become more efficient if terms used in describing agency responsibilities and desirable outputs were standardized. Regular communications aimed at informing the public often improve support for agency activities (Way 1983). Decisionmaking capabilities would be enhanced through using agreed-upon, explicit criteria for evaluations of past performance and decisions about future priorities. In response to these needs, I have developed a fisheries and wildlife indicator system intended to enhance understanding and communication of management responsibilities and outcomes.

What an indicator system can and cannot do

The system of objective fisheries and wildlife indicators can improve resource monitoring and decisionmaking capabilities in several ways. First, the use of intuition and hidden, implicit decision criteria will decline along with the general subjectivity of judgments. The so-called "hidden agenda" will diminish or disappear. Second, using the indicator system will enable more complete monitoring of trends relating to the resource. Trend data will be useful in evaluating agency programs and activities and in the eventual development of computerized aids for

policymakers. Resource and management trends will be recorded in a systematic fashion, not only during crises. Adaptive management, or learning from the results of past management actions (Walters and Hilborn 1978, Bailey 1982), may become a real possibility. Third, using the indicator system will increase the standing of a resource agency in the eyes of the public and its funding sources because information about its activities will be more reliable, consistent, and defensible (Ewing 1968). Fourth, using the indicators will facilitate communicating information to the general public. This in turn influences policy decisions as special interest groups will be acting from a more knowledgeable base. An indicator system can lead to active support for developing policies and legislative programs intended to improve the resource.

There are some cautions involved in using the indicator system, however. First, indicators must be chosen carefully for a particular problem or program. Criteria for including particular indicators in any policy discussion will require continual evaluation of appropriateness. Care must be used to choose the most relevant available indicator for each particular issue. Where subjectivity enters into these decisions, it should be made explicit. Indicators should not become "vindicators" of poor but personal-favorite policies. Second, indicators should not be considered predictors of the future, but rather guides to decisions based on current and past resource trends. Third, change in an indicator value must be interpreted in terms of particular needs and objectives. An increase or decrease in a given indicator is not inherently a "good" or a "bad" situation. Normative decisions must be left to system users (Webber 1975).

Influencing the thought process

Within a decisionmaking framework, the basis for an indicator system derives from Hammond's (1978) taxonomy of modes of thought available to decisionmakers. Hammond's six modes range from "strong analytical experimentation" (mode 1), the most objective, through "weak quasi-rational thought" (mode 6), the most subjective (Fig. 1). Hammond suggests modes 4 through 6 are most relevant to decisionmakers. Mode 4 is the strongest of the three, using cognitive aids such as descriptive statistical analyses, computer simulations of environmental circumstances, and explicit analyses of judgment and decision processes. Hammond considers mode 4 the most desirable, because it provides explicit reasoning for each decision made.

Use of these mode-4 techniques in fisheries and wildlife policymaking, however, is unlikely at the present time. The complex nature of the resource and the lack of complete monitoring capabilities hamper efforts to develop simulation models (Taylor 1981) which may be useful in mode 4 decisionmaking. There is a lack of time-series data on all aspects of fisheries and wildlife resources and management, and their interactions (Miller 1983). This lack of information makes it difficult to develop predictive models to use in mode-4 thought because the causes of resource change are not known (Buckman and van Sickle 1983). The major barrier to mode-4 thought, however, is that decisionmakers are unwilling to trust systems which remove their personal interpretations and influence from the process. Very few decisionmakers are willing to have their own judgmental shortcomings revealed, as occurs with using decision analyses

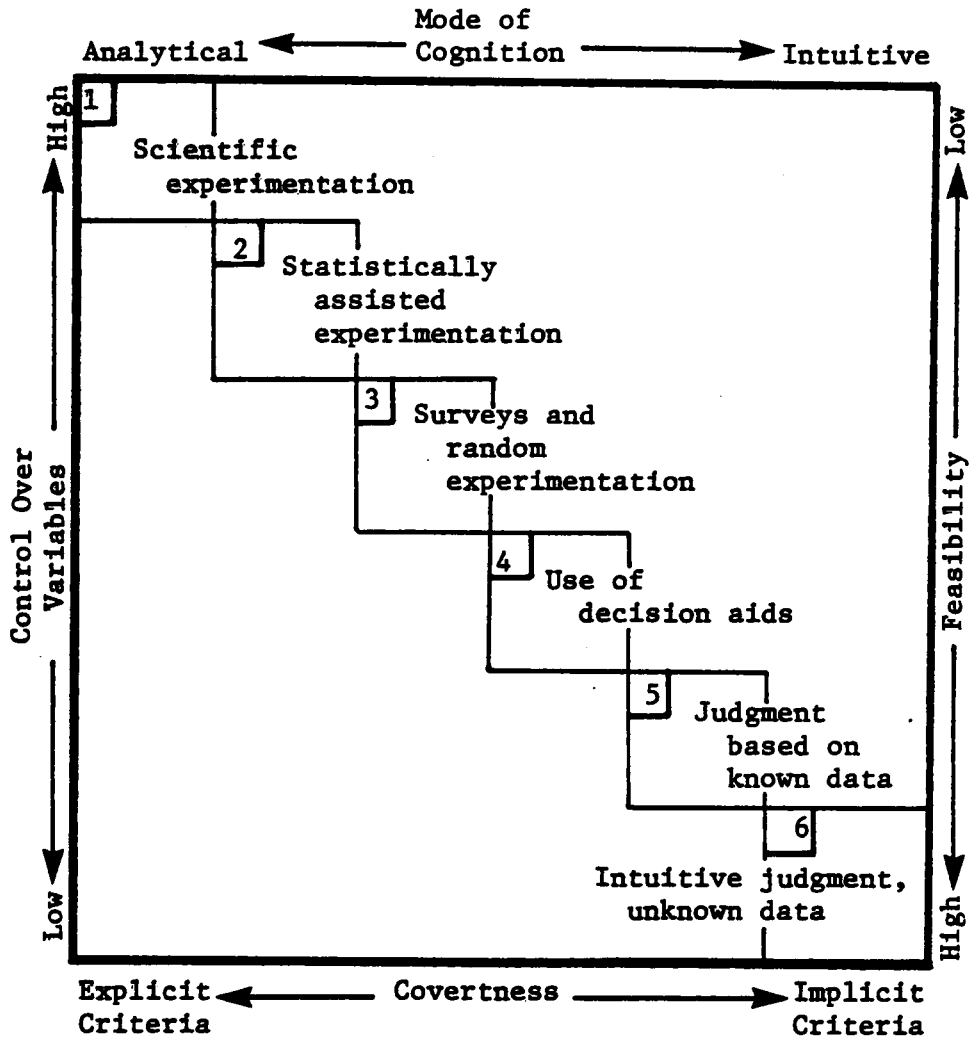


Fig. 1. Matrix of modes of thought (after Hammond 1978). The four axes are as follows: 1) Mode of Cognition refers to the degree to which the thought process can be considered analytical or intuitive; 2) Control Over Variables refers to the degree of control a decisionmaker has over all variables affecting a decision; 3) Covertness refers to the use of implicit or explicit criteria by a decisionmaker; and 4) Feasibility refers to the feasibility (i.e., considering time, costs) of each mode of thought for decisionmaking.

(Hammond 1978). Many decisionmakers in fisheries and wildlife administration feel usurped by the computer (Russell 1982) and thus will not use these methods as intended.

Mode 6, the thought process used by most people most of the time, relies on intuition and involves an uncertain or unknown data base. The National Wildlife Federation's (NWF) annual Environmental Quality Index is an example of mode-6 thinking. The Index is quite subjective (Kimball 1972), reflecting the educated judgments and opinions of NWF regional representatives rather than relying on directly observable, repeatable, and measurable data. The content of the Index is influenced greatly by issues that received media attention or other public recognition within the year. It does not necessarily address those issues which are most useful to resource managers and policymakers (Alan Wentz, National Wildlife Federation, personal communication).

Mode-5 thought involves decisions based on a known, delimited set of data but on unknown weightings of the importance of the data. Although mode 5 lacks the complete rationality of mode 4, the use of objective indicators brings explicit reasoning to the decisionmaking process. The data supporting a particular decision are made apparent. It is within this mode that the fisheries and wildlife indicator system will operate. Once mode 5 is the accepted way of doing business, the profession can move toward incorporating computerized and other decision-aids into resource management (mode 4). Fisheries and wildlife indicators may be used to research specific cause and effect relationships and interactions and may lead to the development of algorithms required for mode-4 decisionmaking aids.

Social indicators as an analogy

I patterned my efforts to develop a system of fisheries and wildlife indicators after the methods used by public administrators in developing a system of social indicators. The fisheries and wildlife profession and public administration share several similarities. Both deal with characteristics that are hard to quantify, yet are necessary to address to evaluate performance. For example, public administrators are interested in the quality of life resulting from social programs, while fisheries and wildlife professionals are concerned with the quality of recreational experiences resulting from people using the fisheries and wildlife resource. People in both professions must deal with multiple objectives and address a variety of programs for a diverse, often conflicting clientele. Both attempt to improve the public good and are publicly accountable for their actions.

The development of social indicators from the early 1960s to the present is well-documented and serves as a useful model for fisheries and wildlife indicators. Many of the stages in social indicator development are evident within the fisheries and wildlife profession.

The social indicator movement began when social scientists rebelled over the use of economic measures of performance as indicators of well-being (Carley 1981). Fisheries and wildlife professionals have also rebelled, calling, for example, not for animal yields as a sole performance criterion, but for the consideration of multiple objectives by managers (Hendee 1974, Nielsen 1976). The first development in the social indicator field was identifying objective data series containing non-economic

information. A similar effort is seen in the "wildlife" section of the Council of Environmental Quality's (1981) Environmental Trends. It is hard to discern any criteria for including a particular trend in the book other than mere data availability.

Once objective, non-economic data had been accepted as the basis for social indicators, interest turned to creating subjective indicators of attitudes. This was the start of the movement to assess "quality of life" (Carley 1981). A similar trend in natural resources is evident in Kellert's (1979, 1980a, 1980b) reports about the attitudes of the American public toward fisheries and wildlife resources.

Interest in social indicators next shifted toward the analysis of trends using accumulated time-series data. It is at this point that the evaluation of fisheries and wildlife resources stands. Systematically collected data are mandated for certain ecological parameters relating to wildlife. For example, the National Forest Management Act of 1976 (PL 94-588) requires "indicator species" be inventoried to determine if habitat management objectives are being met (Thomas 1982). In practice, however, the usefulness of the indicator species approach is limited since it only addresses single-species concerns and ignores other influences (Steele et al. 1984). Still lacking are any efforts to collect social, economic, and other ecological data on the resource in a comprehensive and widely reported fashion. Regier and McCracken (1975) called for such a program within the Canadian resource agencies, urging that priorities be placed on consolidating and maintaining a series of data on ecological, economic, and social factors for monitoring trends.

On the federal level in the United States, the National Academy of Sciences (1975) recognized the need for indicators of the conservation and use of resources. Peine et al. (1980) noted the dispersed nature of natural resource recreation monitoring and the need to consolidate various efforts to use trend data. The fisheries and wildlife indicator system can serve as the first step in meeting these needs.

Scientists have faced several methodological problems in their attempts to construct and use a system of social indicators (Bunge 1981). The same problems were relevant in my work.

The first problem faced in indicator development is deciding what an indicator actually is. I used a working definition of an indicator similar to Bisselle et al. (1971): an indicator is a single measurement of the resource reported in an unaggregated form. It is not a value which combines a variety of parameter measurements into a single integrating measure. I did not attempt to develop algorithms for aggregating individual indicators into a composite value. To do that would require additional analysis and experience based on actual use of the indicators. I felt it would be premature to develop an overall index of the fisheries and wildlife resource before an adequate information base is developed on specific areas of concern. Bisset (1978) suggested avoiding aggregation techniques altogether as they reflect the value judgments of the system designer rather than those of decisionmakers. It would be difficult for a user of the system to understand fully all assumptions and value judgments included in an aggregated measure.

The second problem Bunge (1981) noted is deciding what is to be indicated. The objects of interest in the fisheries and wildlife indicator

system are: 1) the current status of a variety of characteristics of the resource, its management, and use; and 2) observable trends in these characteristics. Defining important characteristics of interest was a major component of my research and is described in detail in Chapter 3.

The third task in indicator development is deciding whether every indicator should be descriptive or if some may be normative. I chose not to include normative indicators in the current system. Value judgments are left to the system users, and are based on their own stated goals, objectives, and interests. I felt that including implicitly value judgments in the system would be opposed to the goals of moving from mode-6 to mode-5 thought.

Finally, Bunge asked, how are indicators to be validated? Pikul et al. (1972) suggested that indicators, especially in an entirely new system, should be validated through use. Therefore, validation was not a focus of my work. The relation of indicator values to the quality of fisheries and wildlife resource characteristics and agency performance must be determined over time.

Statement of objectives

Four major steps were involved in developing the fisheries and wildlife indicator system (Fig. 2). The first step was assessing the current situation in terms of types and availability of resource information. My first objective, described in detail in Chapter 2, was to "identify and describe criteria currently employed in the fisheries and wildlife profession at the state level by which the status of fisheries

and wildlife resources is annually evaluated and results of which are communicated to higher levels of government and/or the public". Performing this analysis allowed me to assess the type, quality, and quantity of performance information currently available through state fisheries and wildlife agencies. I was able to identify the types of information which are made readily available to the public regarding management activities, and what types of information are reported scarcely or not at all. This provided the basis for subsequent work on the indicator system.

The second step in this work was developing a comprehensive classification framework representing all aspects of the fisheries and wildlife resource. In a study of environmental indexes, the National Academy of Sciences (1975) noted one of the major problems in developing and using indexes was the lack of an overall framework designed to unify and systematize the information in them. Issues, policies, and functions for which indexes were to be used should have been identified before the indexes themselves, but were not. Therefore, my second objective was to "develop a comprehensive framework describing the fisheries and wildlife resource system including economic, ecological, programmatic, and social dimensions" before beginning to identify indicators. This work is described in Chapter 3.

Once the classification framework was available, I began the third step, the process of identifying indicators representative of each characteristic in the framework. My third objective was to "identify and select a series of indicators to describe the status, changes, and trends in important fisheries and wildlife resource characteristics over time". This work, which involved extensive analysis of fisheries and wildlife

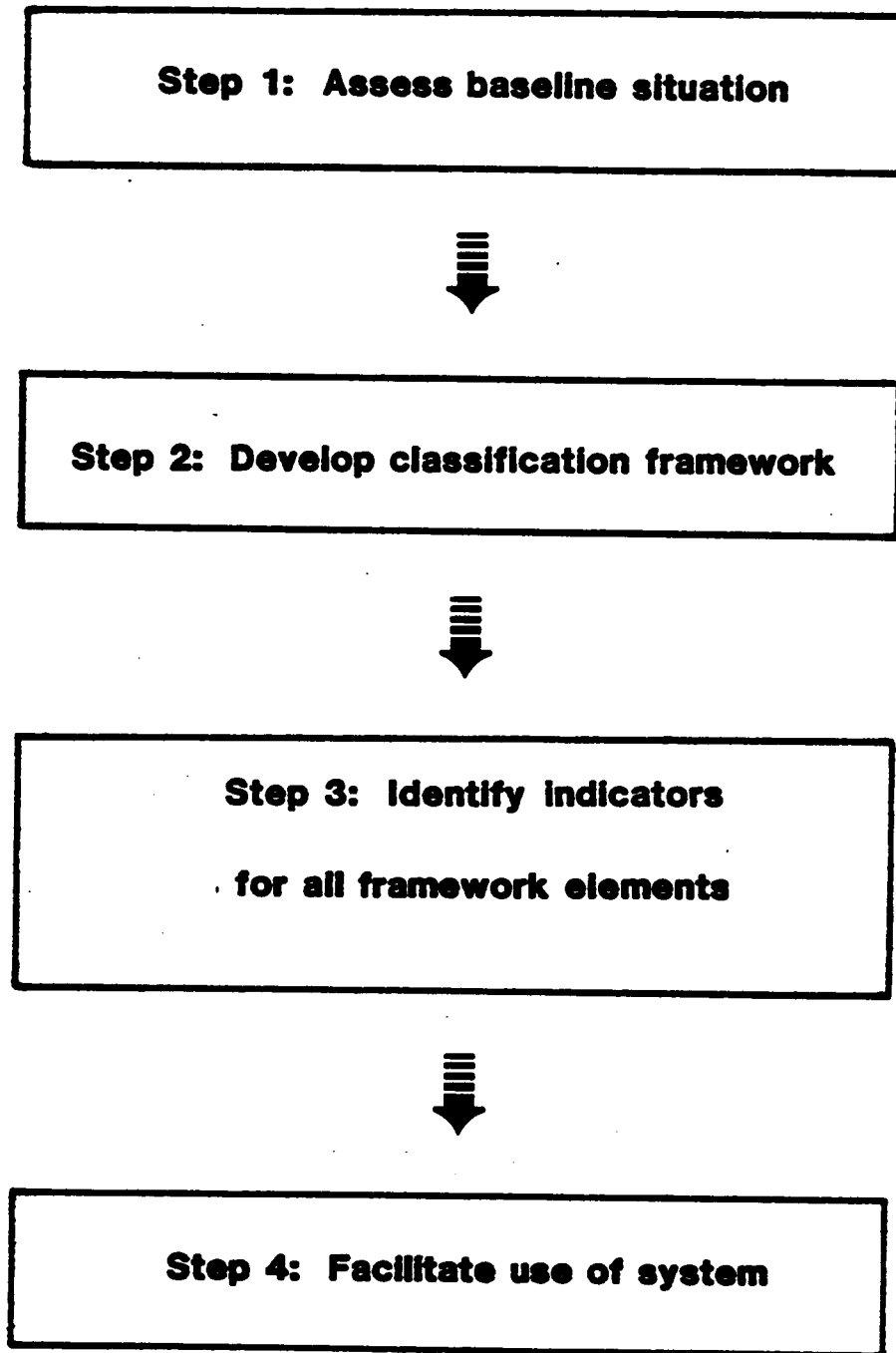


Fig. 2. Flow chart of procedures used in indicator system development.

literature, agency documents, and general indicators literature, is described in Chapter 4.

My last objective was to "describe methods to facilitate state-level agencies using the indicator system". Chapter 5 includes a description of these methods, how the system can fit into a state's planning program, and the impact using the system may have on the future of fisheries and wildlife management.

CHAPTER 2: STATUS OF STATE COMMUNICATIONS

My first objective was assessing the types of information currently made available to the public about the fisheries and wildlife resource, its management, and use. I was interested in information which would be similar in scope and intent to the system of indicators I would be developing. As indicators are intended to be of state-level interest (rather than local) and to be of use in documenting annual trends, I chose to analyze the annual reports of state fisheries and wildlife agencies for information content. The results of this analysis are described in this chapter and in Knuth and Nielsen (in press). A secondary objective was to develop recommendations for improving the content and presentation quality of state agency annual reports.

The annual report has been termed the "cornerstone" of an effective public relations program (Miller 1971). It should serve as an information source, an historical record, and a summary of future goals (Fazio and Gilbert 1981). It is one method for meeting Hendee et al.'s (1974) plea that agencies keep the public informed of management activities to ensure knowledgeable and effective public discussion of resource issues. As the summary of activities and accomplishments, the content of the annual report should indicate what is important to an agency.

I analyzed state fisheries and wildlife agency annual reports to assess the extent to which reports reflected the spectrum of agency responsibilities. I also evaluated the style with which information was presented in the reports.

Methods

I applied the technique of content analysis to analyze the information contained in annual reports. Content analysis is used to make inferences about the content of a document by systematically and objectively identifying specified characteristics (Krippendorff 1980). This technique is used frequently to assess differences among various documents and to identify frequencies of occurrence of an item and associations or relations among items. Stankey (1972) encouraged using this technique to analyze public comment received by natural resource agencies.

The subject of my analysis was the most current available annual report from each state fisheries and wildlife agency. Report years ranged from 1978 to 1984; 90% were prepared for 1981-1984. Staff in Colorado, Iowa, and Kentucky do not prepare reports, and thus these states were not included. I defined an "agency" as being that administrative unit with primary responsibility for fisheries and/or wildlife resources. If an agency thus defined was part of a larger unit's report (e.g., Wildlife Division in Department of Natural Resources), I also analyzed sections of the annual report which addressed activities typically associated with fisheries and wildlife management. For example, I included law enforcement and education divisions, but not park management. A pair of agencies manage fisheries and wildlife in Maine, Pennsylvania, and Virginia, so I pooled results from the reports within those states to arrive at a total for each state.

Selection of different subject matter categories which will be used to classify information reported is the first step in content analysis

(Stankey 1972). In order to select categories, I analyzed the document of one state in each of five geographical regions. These were: Northeast, New Hampshire; Southeast, Virginia; Midwest, Minnesota; Northwest, Idaho; and Southwest, California. For each region, I chose the document which on first examination appeared to meet the criteria for average or above average length, clarity of organization, and ease of reading as my purpose was to scan the documents rather than complete an in-depth analysis. Based on this procedure, I identified 42 categories of information which I classified into five major groups for later analysis (Table 1).

I assessed content of the reports by assigning information reported into one of the 42 categories. Each time a new piece of information was mentioned, I listed it as a distinct information item in a category. For example, trout harvest reported as number, weight, and species caught was listed as three separate information items in the category of Fisheries: Recreational Harvest. Length of textual coverage (e.g., number of sentences) was not a criterion for identification. Qualitative information, therefore, tended to occupy more physical space per item recorded than did quantitative information. I also characterized reported information as being quantitative or qualitative; comparative or noncomparative with information from past years; and textual, graphical, tabular, or pictorial in presentation format.

I calculated relative frequencies with which information was reported in all categories and in all presentation formats for each state. I compared the relative variability of reporting frequencies for each information category using the Coefficient of Variation (Daniel 1974).

Table 1. Information categories for content analysis of annual reports.

ADMINISTRATIVE	FISHERIES	ECONOMICS AND FACILITIES
Agency Description	Research	Revenue
Agency Goals	Game Species	Expenditures
Personnel	Nongame Species	Commercial Market
Accounting	Hatchery Production	Present Holdings
Engineering	Stocking	Land Acquisitions
Data Processing	Recreational Harvest	Aquatic Acquisitions
Planning	Commercial Harvest	Structure Acquisitions
Legislation	Habitat Management	Construction
Professional Commentary	Environmental Quality	Maintenance
Social Research		
Enforcement		
Information/Education	WILDLIFE	PUBLIC INVOLVEMENT
	Research	Recreational Fishing
	Game Species	Commercial Fishing
	Nongame Species	Trapping/Hunting
	Harvest	Nonconsumptive Use
	Habitat Management	Public School Education
	Depredation/Damage	Landowners/Clubs

I calculated content diversity (D) for each state using a modification of Simpson's index (Peet 1974), $D = 1 - \sum_{i=1}^{42} p_i^2$, where p_i is the proportion of total information items reported by each state in category i . I compared reporting characteristics across states using an hierarchical cluster analysis (Lorr 1983) programmed in the Statistical Analysis System computer package (SAS Institute 1982).

I also compared the percent of the agency budget and the percent of the annual report allocated to a particular program to determine whether report content paralleled program size. After the methods of Boggis and Hamilton (1984), I used expenditures as a rough indication of agency priorities among programs. As Glass (1981) reported, it is often difficult to isolate desired financial figures in annual reports, depending on the way they are reported. For this analysis I assigned each of the Public Involvement categories to one of the other 4 groups because few states specifically included public involvement as a budgeted activity. This allowed me to compute correlations for 18 states which reported sufficient budgetary data (FL, GA, ID, LA, MA, MI, MO, MT, NE, NC, NM, OH, OK, OR, PA, UT, VA, WV).

Results

States prepared highly diverse annual reports (Table 2). Overall diversity of report content, based on coverage of each of the 42 individual categories, ranged from 0.48 (SD) to 0.96 (HA). Of 47 states, 39 had a diversity above 0.90, indicating most state reports contain infor-

mation in a variety of categories. The major exception was South Dakota, the annual report of which was mainly financial.

The most highly reported category group was Administrative information (Table 2), which ranged from 7.3-63.7% of report content. The average total coverage given to non-resource matters (administration, economics, and facilities) exceeds that given to resource matters (fisheries and wildlife). Individual reports varied, however, in their percentage devoted to Fisheries (0.0-63.8%), Wildlife (0.0-47.5%), Economics (1.2-92.7%), or Public Involvement (0.0-43.9%) information.

Category comparisons

Of the 42 information categories, the 15 listed in Table 3 accounted for about two-thirds of the average report. The other information categories will not be discussed in detail because of their apparent lack of relative importance. Six of the top 10 categories address administrative or economic information rather than resource information.

The most reported and least variable category was Information/Education. This administrative division of most agencies is presumably the most familiar with reporting techniques due to the nature of its work and probably prepares the annual report in most agencies. Other highly reported categories with low variability include Professional Commentary, Personnel, and Enforcement. Emphasis on activities such as employee training, attending meetings, participating in environ-

Table 2. Content group and report characteristics for all states.

State	Diversity Index	Content Group (%)					Public Involvement	Report Length (Pages)
		Administrative	Economics	Fisheries	Mildlife			
AL	0.923	37.8	28.8	22.4	6.1	4.7	55	
AK	0.912	63.7	19.1	12.3	0.0	5.5	113	
AZ	0.939	32.5	28.4	30.1	0.0	9.0	90	
AR	0.898	17.2	12.4	63.8	0.1	6.5	128	
CA	0.945	30.6	9.8	45.8	4.8	8.6	113	
CT	0.941	19.2	12.0	15.9	35.5	17.6	8	
DE	0.931	36.6	9.8	19.5	17.1	9.7	15	
FL	0.947	36.1	6.2	24.3	18.7	15.1	21	
GA	0.902	21.3	9.8	53.6	0.0	15.2	36	
HA	0.958	22.0	1.2	31.8	15.6	14.6	103	
ID	0.932	19.9	9.6	27.3	20.9	22.4	76	
IL	0.945	35.2	10.0	17.0	22.1	15.3	23	
IN	0.933	20.9	17.5	11.3	25.3	25.0	16	
KA	0.746	9.1	0.6	12.8	33.8	43.9	120	
LA	0.935	36.4	13.5	31.4	12.1	6.6	9	
ME	0.925	47.3	18.5	26.6	0.6	7.0	60	
MD	0.949	43.3	10.6	34.0	6.0	6.0	52	

Table 2. Content group and report characteristics for all states (continued).

State	Diversity Index	Content Group (X)						Public Involvement	Report Length (Pages)
		Administrative	Economics	Fisheries	Wildlife				
MA	0.948	25.0	16.8	14.1	33.0		8.1	54	
MI	0.955	30.9	17.5	17.0	24.4		10.1	140	
MN	0.947	28.5	17.4	21.3	16.5		16.5	123	
MS	0.930	43.0	11.4	23.5	8.5		14.0	57	
MO	0.940	32.2	16.1	9.8	15.0		26.7	153	
MT	0.894	28.7	17.5	7.9	21.6		24.2	24	
NE	0.880	50.7	18.1	8.8	13.6		8.9	50	
NV	0.933	48.8	15.8	17.0	4.8		13.3	9	
NH	0.937	37.7	23.5	5.4	26.7		6.6	35	
NJ	0.946	31.1	11.0	16.1	22.8		19.3	20	
NM	0.936	35.6	16.5	15.2	17.8		14.9	60	
NY	0.912	15.7	3.6	44.8	29.8		6.2	24	
NC	0.936	44.5	6.8	19.8	18.2		9.6	32	
ND	0.915	12.9	8.0	11.6	47.5		20.3	33	
OH	0.888	41.8	5.7	9.8	23.0		19.7	38	
OK	0.938	28.2	25.6	21.9	14.0		10.4	60	
OR	0.954	24.6	21.1	35.6	10.3		8.6	88	

Table 2. Content group and report characteristics for all states (continued).

State	Diversity Index	Content Group (%)							Report Length (Pages)
		Administrative	Economics	Fisheries	Wildlife	Public Involvement			
PA	0.914	46.7	33.5	6.8	7.5	5.3			36
RI	0.919	22.3	4.8	27.1	26.9	18.9			6
SC	0.917	34.7	8.9	32.7	13.2	10.2			109
SD	0.477	7.3	92.7	0.0	0.0	0.0			34
TN	0.911	44.2	27.4	10.8	12.9	4.5			23
TX	0.939	40.5	18.7	15.2	19.0	6.2			40
UT	0.910	15.9	33.2	11.2	16.4	23.7			96
VT	0.936	53.8	11.3	12.5	13.7	8.0			60
VA	0.896	29.8	22.3	33.6	3.1	10.6			52
WA	0.928	27.4	2.8	48.1	4.3	17.6			12
WV	0.931	39.5	14.0	19.8	12.7	14.2			128
WI	0.944	45.3	9.6	18.9	16.6	9.4			35
WY	0.849	16.6	13.8	7.7	23.1	39.0			73
MEAN	-	32.2	16.2	21.8	15.7	13.6			58

mental review processes, making arrests, and issuing citations appears to be common among all agencies.

Combining categories on Revenue and Expenditures accounts for 10% of the average report. This reflects the importance of reporting the handling and distribution of funds. Agency personnel, the public, and higher levels of government which receive the report are very interested in how funds are generated and disbursed (Wambach 1979).

The ten least-reported categories were Aquatic Acquisitions (0.2%), Structure Acquisitions (0.2%), Engineering (0.3%), Public School Education (0.3%), Nongame Fish Species (0.4%), Nonconsumptive Use (0.5%), Social Research (0.6%), Data Processing (0.7%), Accounting (0.7%), and Depredation/Damage (0.8%).

The most variable categories were Aquatic Acquisitions (Coefficient of Variation, hereinafter COV, 3.81), Public School Education (COV 2.65), and Nongame Fish Species (COV 2.62). The higher COV's are believed to reflect the degree of importance agencies place on these activities, indicating a more varying emphasis on a general aquatics program or on involvement with state public school systems than on other activities. Reporting on these categories, in particular, illustrates the need for an indicator system that can address the entire spectrum of agency responsibilities.

Table 3. Content characteristics of the most frequently reported categories in annual reports (all values are %). Rows do not sum to 100% because qualitative and noncomparative characteristics and pictorial format are not shown.

Category	Mean	Characteristic			Format		
		Quantitative	Comparative	Textual	Tabular	Graphical	
Information/Education	8.6	50.9	2.0	89.0	8.1	0.1	
Trapping/Hunting	6.3	78.2	21.8	71.0	21.6	2.1	
Revenue	6.0	80.2	10.9	49.3	44.4	3.9	
Enforcement	5.8	58.9	13.9	74.9	21.9	1.9	
Personnel	5.1	46.4	1.9	81.3	11.8	0.5	
Fisheries Research	4.8	30.3	0.7	94.5	2.1	0.0	
Expenditures	4.0	93.1	5.0	32.9	59.8	7.1	
Wildlife Harvest	3.9	89.6	22.9	65.0	31.5	3.3	
Professional Comment	3.8	27.8	3.1	94.7	4.9	0.3	
Recreational Fishing	3.7	68.1	9.5	73.0	18.1	2.4	
Wildlife Habitat	3.7	57.8	2.5	88.5	7.3	0.0	
Fish Stocking	3.6	79.3	2.4	59.2	25.7	0.0	
Commercial Harvest	2.9	81.9	12.5	77.1	16.8	4.1	
Wildlife Game Species	2.9	52.0	7.2	84.9	2.5	1.7	
Wildlife Research	2.7	32.3	2.5	94.0	1.5	0.0	
MEAN	-	61.8	7.9	75.3	18.5	1.8	

Information format

Quantitative information was dominant in reports (Table 3) compared to qualitative information. Categories with the greatest frequencies of quantitative data included Expenditures, Revenues, Wildlife Harvest, and Commercial Fisheries Harvest. The lowest frequencies of quantitative data were reported in the Research categories and Professional Commentary. Research tends to be reported qualitatively as descriptions of activities and results, while Professional Commentary is reported as descriptions of the type of environmental review performed or purpose of meeting attended. Coupled with quantitative statistics on research projects (e.g., number completed) and commentary (e.g., percent review requests answered), such descriptions can aid greatly in understanding the responsibilities of an agency and how well they are being met.

Comparison with data from previous years was uncommon in the reports (Table 3). Comparative data occurred most frequently in the Wildlife Harvest and Hunting/Trapping categories, where continuous monitoring activities assure that comparative data will be available. An established indicator system would ensure consistent monitoring across a wide variety of agency activities.

Annual reports were mostly text, with relatively few tables, graphs, and pictures (Table 3). Graphs appeared very seldom in reports, except for reporting financial data and Commercial Fisheries Harvest. The more extensive use of tables rather than graphs may indicate reporting actual data is judged more important than facilitating rapid interpretation of

the data, or it may reflect the unavailability of (or lack of access to) graphic and illustrative talent.

Budget and group comparisons

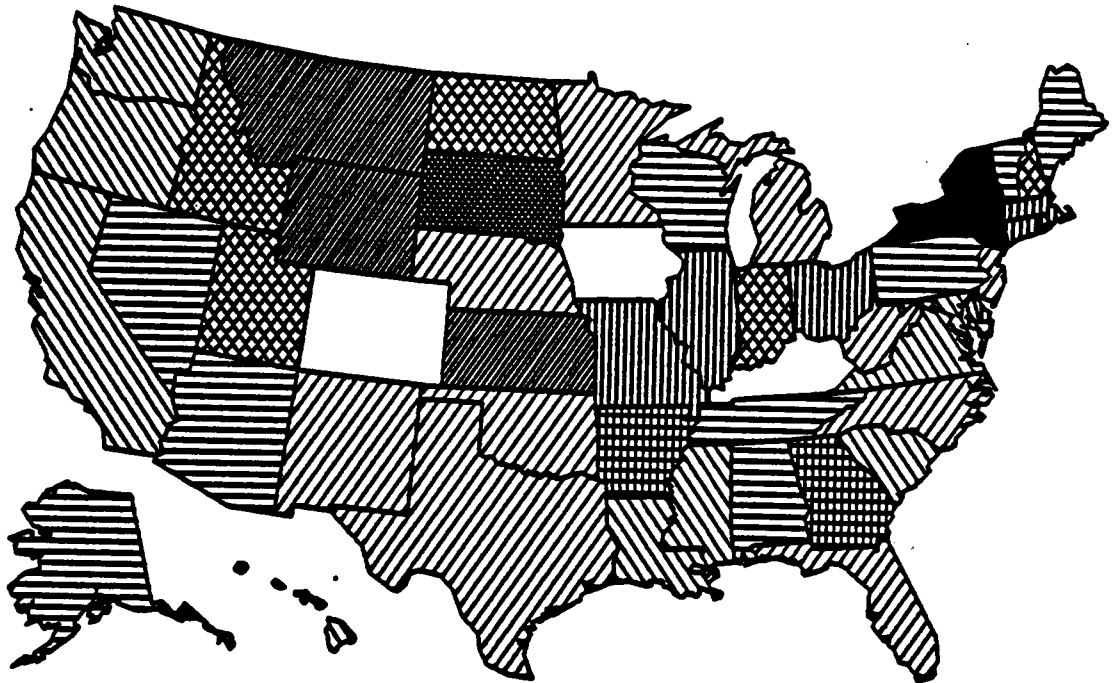
Correlations between the percent of the agency budget and the percent of the annual report allocated to a particular category group are shown in Table 4. Fisheries was the only group for which report emphasis was correlated significantly with the budget allocation. Report emphasis was more variable for the other groups of information. The mean percent of information devoted to Wildlife and Facilities information was less than the associated mean budget, while the mean percent of information devoted to Administrative information was greater than the mean percent of the budget received.

State comparisons

Similarities in information reporting among states were identified using cluster analysis. Nine major associations were identified (Fig. 3), and are classified according to the relative emphasis placed on each major information group as indicated in the legend. Only one state emphasized Fisheries and Wildlife information. The largest association contained ten states emphasizing Wildlife and Administration. Two associations contained nine states each, emphasizing Administration and either Fisheries or Economics.

Table 4. Correlations between percent of budget and percent of report allocated to each major group (N=18).

Group	Mean Percent of Budget	Mean Percent of Report	r
Administration	35.2	44.8	0.314 (P=0.2046)
Fisheries	25.2	24.6	0.812 (P=0.0001)
Wildlife	22.6	20.9	0.461 (P=0.0544)
Economics/Facilities	16.9	9.6	0.093 (P=0.7148)
	100.0	100.0	



- Fisheries and Wildlife (1)**
- ▨ Fisheries (2)**
- ▩ Fisheries and Administration (9)**
- ▧ Wildlife and Administration (10)**
- ▦ Wildlife and Public Involvement (5)**
- ▥ Public Involvement (3)**
- ▤ Wildlife, Public Involvement, and Administration (7)**
- ▣ Administration and Economics/Facilities (9)**
- ▢ Financial Report only (1)**
- No Report Prepared (3)**

Fig. 3. Results of cluster analysis based on comparison of annual report content among states. Clusters are identified by relative emphasis on types of information as indicated in the legend. Numbers in parentheses indicate quantity of states in each cluster.

If information in annual reports reflects the importance given certain management objectives, clustered states are likely to share similar objectives. Managers and biologists from states within clusters may benefit from consulting with each other about their activities and strategies.

Discussion and recommendations

Most resource agencies contact the public through a variety of media, including magazines, public-service announcements on radio and television, interpretive brochures, and public meetings. With the exception of public meetings, however, these communications help people use the resource rather than examine management policies and their implications. Public meetings achieve the latter purpose, but generally address single issues rather than a spectrum of agency activities and responsibilities. Moreover, public meetings reach only a few hundred people at a time. In contrast to these communications, the annual report gives the public facts and descriptions about the entire agency. It is the one communication avenue through which an agency is expected to say what it actually does. What I have found in my analysis, however, is that if agencies really did what they are reporting, they would be administrative and financial institutions.

Administrative information is clearly emphasized in these reports, with a relative paucity of information reported on the fisheries and wildlife resource and its use. Although many annual reports are legally mandated and prepared for legislative oversight committees or internal audits, all are available for public distribution. I recognize the need

to summarize legally required information, but suggest (along with Wambach 1979) that public acceptance and support for agency programs is strongly tied to how adequately people feel their interests are being served. A report of the activities of the year centered largely around administrative concerns does little to inform the public or oversight committees about actual agency outputs in terms of population and habitat management or provision of recreation opportunities. Although an agency may be effective in its internal operations, such information does not inform the reader as to how well it is accomplishing its goals and performing its mission (Cameron 1980). The impression left by the typical annual report is not one of an agency concerned with fisheries and wildlife resources and recreation. **Recommendation 1. Annual reports should deemphasize administrative information and increase information reported on fisheries and wildlife resources, their use, and actual management activities.**

The trend toward comprehensive planning systems in state agencies (Crowe 1983) may stimulate a shift in emphasis to reporting on resource-based outputs rather than administrative inputs and activities. The use of such planning systems makes more complete monitoring of resource-based data a necessity, since a key component of these systems is an evaluation of how well all objectives have been met. As Cameron (1980) noted, it is difficult to evaluate the progress of an agency if the criteria used to identify progress have not been made explicit. Therefore, objectives should be stated in terms of an output to be produced. The annual report can be an effective addition to a comprehensive planning program as the forum for reporting agency outputs and progress on objectives (Anonymous

1984). **Recommendation 2. Correspondence between management objectives and information included in annual reports should be stressed. Annual reports should address each objective and report on the progress of producing each desired output.**

Trends in resource management, status, and use should be reported more than they are reported at present. Reporting comparative statistics would allow the progress of an agency to be assessed over time by relating present performance to performance in previous years (Gerrity 1967). The use of trend data would highlight management activities which have been repeated successfully from year to year, or conversely, activities which are repeated from year to year with little apparent benefit. Such comparisons would be extremely useful in the evaluation component of a comprehensive planning system, as they might clarify objectives which may need to be reconsidered. Further, the reporting of population and habitat trends may help to avoid crisis situations described by Way (1983). For example, in recent years many public relations problems have centered around wildlife populations overcrowding the available habitat (e.g., Florida Everglades deer). If population statistics are reported on a yearly basis, indicating population trends, this situation may not come as such a surprise to the public. Way (1983) warned against this "reactive" approach to public information and encourages a more active role in regularly communicating resource statistics to the public. **Recommendation 3. An annual report should address an agency's performance over the past year, how this relates to the performance of previous years, and what is expected in the future.**

With this method, a clear assessment of an agency's progress over time becomes possible. Public comment regarding an agency's future direction would also be stimulated. Annual reports may not adequately reflect agency performance because there seems to be a lag in reporting new programs. For example, nongame tax checkoffs have increased in popularity but nongame species receive relatively little emphasis in annual reports (Fish 0.4%, Wildlife 1.7%). More states are becoming involved with public school education but annual reports do not yet address these activities in detail. Nonconsumptive users of the resource outnumber consumptive users (USDI and USDC 1982), but agencies currently report very little on nonconsumptive activities. Agencies may be more likely to anticipate such shifts in public interests if future expectations are included along with trend data in annual reports. **Recommendation 4. Annual reports should include early information on evolving programs so that future development can be assessed.**

The results of the cluster analysis illustrate the usefulness of cross-state comparisons. Planners, managers, and biologists from states within clusters may benefit from consulting with one another about their programs and strategies, since clustered states are likely to share similar overall goals. Moreover, if a state agency desires to change its management emphasis, states within the appropriate cluster may be good models. To facilitate further this exchange of information, efforts should be made to develop some standardized indicators of agency performance that would be reported every year (Knuth and Nielsen 1983). These measures would be included along with topical concerns which may change as objectives of an agency change. The use of standardized meas-

ures would allow comparisons among state agencies and may encourage the exchange of information and expertise. **Recommendation 5. Expand standardized measures of agency performance to allow trend analysis within a state and comparisons of progress among states.**

Finally, annual reports will receive little public attention if they are not presented attractively and in a manner easy to read. The design of the annual report and the manner in which information is presented are critical to attracting the reader's attention (Ruchti and Wasserman 1983). Miller (1971), for example, suggested that not more than 50% of a report should be textual, with the remainder composed of charts, pictures, and graphs. At present, reports contain a mixture of quantitative and qualitative information. The majority of reports, however, consist largely of text rather than a combination of text, tables, and illustrations. The National Survey of Fishing, Hunting, and Wildlife-associated Recreation (USDI and USDC 1982) is a good model for states to follow if they desire to improve their annual reports. The first half of this report consists of topical data summaries with eye-catching graphics, while the latter half contains statistical tables and appendices. The reader can choose easily that section which provides the desired information. **Recommendation 6. Annual reports should be designed to attract readers. A variety of presentation techniques should be used, including textual, tabular, and graphical methods.**

The annual report presents itself as a useful medium through which to report on the status of fisheries and wildlife indicators. Use of the indicator system described in this report will facilitate meeting the six recommendations listed above.

CHAPTER 3: CONCEPTUAL FRAMEWORK

Many attempts at designing evaluation processes and indicator systems have been hindered by the lack of an overall organizational framework. Without a conceptual framework that organizes all components of an indicator system, selecting potential indicators often becomes an end in itself without regard to the intended use of the indicators (National Academy of Sciences 1975). Cernea and Tepping (1977) suggested that a framework giving a conceptual understanding of an agency's function and responsibilities was necessary before developing any type of evaluation system for that agency. Porter and Chubin (1982), discussing science indicator systems, also stressed the need for using a model illustrating inputs, outputs, and impacts. Therefore, the second objective of my work was to provide an organizational or conceptual framework identifying the issues and concerns important to all aspects of fisheries and wildlife management. The framework provides a basis for selecting indicators that reflect the spectrum of management responsibilities.

A secondary use of the framework is to stimulate discussions about the scope of responsibilities and concerns of fisheries and wildlife agencies. Clear definition of the goods and services provided by fisheries and wildlife management is necessary for managers to know what to produce and how to produce it, yet goods and services are rarely well defined in management discussions (Driver et al. 1984, Driver 1985). Resource management agencies have difficulty agreeing on "product" defi-

nitions, and thus are hindered in attempts to develop explicit management objectives and standards for monitoring agency performance (Driver 1985).

The fisheries and wildlife resource framework I developed is a 16-cell matrix representing the interactions of the four resource categories People, Populations, Habitat, and Administration, and the four resource components Inputs, Processes, Outputs, and Impacts (Fig. 4). I felt it was useful to divide the fisheries and wildlife resource system into these four categories to address explicitly important resource attributes. User-oriented management has been recognized as lacking in many fisheries and wildlife programs (Bennett et al. 1978, Snepenger and Ditton 1985), thus the need for the "People" category. Driver (1985) noted the importance of considering the administrative component of management, thus the "Administration" category. The components of Inputs, Processes, Outputs, and Impacts were patterned after the Outdoor Recreation Program Evaluation Framework (ORPEF) (Driver and Rosenthal 1982). The ORPEF was designed to encourage viewing outdoor recreation resource management as a production process, with specific inputs and outputs identified for eventual evaluation purposes. The management of fisheries and wildlife can be viewed in the same manner, in which identifiable outputs are produced from a given set of inputs. Given the similarities and dependencies between recreation management and wildlife management, the use of similar frameworks may stimulate more coordinated management and research.

In the ORPEF, four basic components of outdoor recreation are identified: inputs, processes, outputs and their use, and the impacts of output production and consumption. These basic components are expanded

Resource Category

Resource Component	People	Populations	Habitat	Administration
Inputs				
Processes				
Outputs				
Impacts				

Fig. 4. Resource matrix skeleton illustrating 16 cells for which important aspects of fisheries and wildlife management were identified for the conceptual framework.

to include more specific inputs (e.g., land, labor, time, money), outputs (e.g., recreation opportunities), etc. This same approach, the input-output model, is the basis for most conceptualizations of the fisheries and wildlife resource system. Bell and Thompson (1973) called for evaluation systems to address input-output relationships in fisheries and wildlife management. Hendee (1974) used the terms resource (e.g., game, fish), means of use (e.g., hunting, fishing), product or satisfactions (e.g., exercise, companionship), and goals or benefits (e.g., health, self-esteem). Giles (1978) preferred the terminology of general systems theory, in which context, inputs, processes, outputs or objectives, feedback, and feedforward are identified. Nelsen et al. (1983) suggested the use of "work units" (i.e., combined inputs and processes) and outputs or benefits in determining if Forest Service goals are being accomplished. Clearly, the precedent exists for applying the input-output approach to fisheries and wildlife resource management.

The traditional focus of fisheries and wildlife management has been on the "input" and "process" side rather than on "outputs" and "impacts" (Crowe 1983). Traditional concerns have included inputs such as facilities, money, and personnel, and processes such as miles of road paved or numbers of fish stocked. Recently, the focus of management has begun to change, emphasizing outputs such as deer, waterfowl, and fish harvests, and impacts such as user density (Crowe 1983). A balance among these four components is desirable in a conceptual framework to represent all aspects of fisheries and wildlife management. Once the indicator system is in use, it may be possible to add predictive power by relating one level of

indicator values (e.g., inputs) to another level (e.g., outputs) over time.

Methods

I constructed the fisheries and wildlife resource framework in three steps. The first step involved an extensive search of the literature to identify resource characteristics which would be representative of each of the 16 matrix cells. Resource characteristics describe aspects of fisheries and wildlife resources, their management, or use which are of interest at the state-level. This literature search was designed to identify all possible resource characteristics for a complete description of fisheries and wildlife management. I used four major types of literature sources: recreation; environmental; fisheries and wildlife administration; and social assessment. Recreation literature included evaluations and assessments of current outdoor recreation use and theoretical discussions of the important aspects of outdoor or wildlife-oriented recreation. Environmental literature included explanations of environmental impact assessment work, descriptions of environmental indicator systems, and reports on environmental trends concerning fisheries and wildlife resources. Fisheries and wildlife administration literature included descriptions of actual or proposed agency inventory systems, evaluations of management, and state agency reports and planning documents. Social assessment literature included descriptions of social indicator systems, social impact assessment, and social accounting. The specific sources I used are listed by source type in Table 5.

Table 5. Literature sources for resource framework construction, listed by source type.

<u>Administration</u>	<u>Recreation</u>	<u>Social Assessment</u>
Addis (1983)	Bryan (1983)	Bunge (1981)
Alward et al. (1984)	Charbonneau and Hay (1978)	Cernea and Tepping (1977)
Applegate and Witter (1984)	Commonwealth of Virginia (1984)	Chandrasekar (1981)
Arizona Fish & Game Dpt. (1980)	Driver and Rosenthal (1982)	Etzioni (1970)
Arizona Fish & Game Dpt. (1982)	Hendee (1974)	Gross (1966)
Bean (1983)	Kinman and Hoyt (1984)	Lamson (1973)
Cutler (1984)	Knopf et al. (1973)	Levy (1973)
Driver et al. (1984)	Outdoor Rec. Pol. Rev. Grp. (1983)	Meidinger and Schnaiberg (1980)
FAO (1983)	Peterle and Scott (1977)	National Science Board (1981)
Federal Register (1977)	Potter et al. (1973)	Peterson (1981)
Florida Game & Fish Com. (1984)	Schole et al. (1973)	Pyatt and Round (1977)
Forest Service (1984b)	Shabman and Ostrander (1982)	Rau and Hooten (1982)
GAO (1981)	Stankey et al. (1985)	Ross et al. (1979)
Giles (1978)	Talhelm (1973)	Russett (1970)
Glover and Baskett (1984)	USDI and USDC (1982)	Schoenfeld (1978)
Heberlein and Klepinger (1984)	Vaughan and Russell (1982)	Stagner (1970)
Henderson (1984)	Meithman (1978)	USDC (1980)

Table 5. Literature sources for resource framework construction, listed by source type (continued).

<u>Administration (cont'd)</u>	<u>Environmental</u>
Kellert (1984)	Bisselle et al. (1971)
Knuth and Nielsen (in press)	Conservation Foundation (1982)
Loomis et al. (1984)	Conservation Foundation (1984a)
Lyons and Leedy (1984)	Conservation Foundation (1984b)
Martin et al. (1983)	Council on Environmental Quality (1982)
Mattfield et al. (1984)	Czarnecki (1983)
Miller and Hay (1984)	Jenkins (1972)
Nelson et al. (1983)	Judy et al. (1984)
Noble (1985)	Margules and Usher (1981)
Sport Fishing Institute (1985a)	National Wildlife Federation (1985)
Sport Fishing Institute (1985b)	Rau and Hooten (1982)
Sport Fishing Institute (1985c)	Regier (1972)
Sport Fishing Institute (1985d)	Regier and McCracken (1975)
Stephenson (1985)	Roome (1984)
Wildlife Management Inst. (1977)	Tubbs and Blackwood (1971)

I used the "diminishing returns" method to determine the number of documents to examine in developing the framework. In this method, the cumulative number of resource characteristics identified is plotted against the number of sources examined. The curve plateaued when few new resource characteristics were identified. Braun-Blanquet (1932) noted that when the curve becomes horizontal the endpoint of the study is reached. In this work, the endpoint signified that a comprehensive coverage of resource characteristics had been obtained.

I applied the diminishing returns method to each of the literature source types. I used as the criterion for ending each literature search the point at which 10 consecutive sources yielded a slope of ≤ 1.5 . One exception to this method was made when examining administration literature. For this source type, the criterion used was 20 consecutive sources yielding a slope of ≤ 1.0 . I chose the stricter criterion for administrative literature because it will be primarily the administrative sector in fisheries and wildlife management which will be using the indicator system. By using a stricter decision criterion, I hoped to ensure identifying as many important resource characteristics as practically possible which are documented as being of concern to fisheries and wildlife administrators.

The second step in constructing the framework was to summarize the findings of step 1, the literature search. For each individual source document, only presence of a resource characteristic was noted. I did not tally repetitions within one document, nor did I judge extent of coverage. The object of the search was to identify all possible resource

characteristics, and later to choose from among them to create the resource framework (step 3). I classified each resource characteristic identified into one of the 16 category-component cells of the resource matrix. I calculated the frequency with which each characteristic was mentioned in each source type.

The third step involved selecting a specific framework from among all the characteristics identified in the literature search. The design objective was to identify no more than five resource characteristics for each of the 16 cells of the matrix. This was done to reduce the large number of characteristics identified in the literature search to a more workable number and to achieve some balance among the 16 cells. (In some instances, fewer than 5 characteristics had been identified in the literature search.) The decision criteria applied in determining which characteristics would be included in the final framework are listed below in order of application. For example, if 3 characteristics for a particular cell were identified using criterion 1, then additional criteria were applied in order until a total of 5 characteristics had been identified.

- 1) A characteristic was included if it was mentioned in at least 10% of sources in each of the four source types. This indicated a characteristic with importance to all disciplines considered.

- 2) Characteristics mentioned in 20% of administration sources were included to ensure that traditional agency concerns would be addressed.

- 3) Characteristics mentioned at least once in each of the four source types were included to ensure that a breadth of interests was

represented. These "universal" characteristics may be just emerging in terms of public interest, and may become more important in the future.

4) Characteristics mentioned in at least 10% of sources in each of three source types.

5) Characteristics mentioned in at least 10% of sources in each of two source types.

6) Characteristics mentioned in at least 10% of sources in one source type.

7) Characteristics mentioned at least once in three source types.

8) Characteristics mentioned at least once in two source types.

9) Characteristics mentioned at least once in one source type.

Using these criteria, I identified up to five resource characteristics for each of the 16 matrix cells. Upon review of the results, I included an additional seven characteristics based on my own subjective judgment and experience. These were primarily characteristics that I felt were of near-future importance and were under-represented in the literature. I included them as one way of addressing Recommendation 4 in Chapter 2, the recommendation that reporting on programs begin early in the evolution of a program.

Results

The diminishing returns method was useful for determining the number of source documents consulted. I examined 32 administrative sources, 17 recreation sources, 17 social assessment sources, and 15 environmental

sources (Fig. 5). As expected, there was a significant relation between the type of literature source and the number of resource characteristics identified in each category ($\chi^2=31.68$, d. f.=9, $P<0.01$).

Social assessment literature yielded the lowest total number of resource characteristics, as expected. Social assessment literature was most pertinent to the People and Administration categories in terms of the number of resource characteristics identified (Table 6). I did not expect social assessment literature to address population and habitat concerns in great detail.

The greatest number of characteristics in the People category were identified in recreation literature (Table 6). This also was expected since recreation is inherently concerned with people's use of resources. Recreation literature also mentioned habitat concerns relatively frequently, which probably reflects the importance of having an adequate land and water base on which recreation activities can occur.

I identified the greatest number of population and habitat characteristics through environmental literature (Table 6). This also was expected, since "environment" is comprised of populations and habitat. All source types included characteristics in the People category to a greater degree than they addressed other categories. Administrative literature addressed characteristics in all categories, with the greatest mention of People and Administration characteristics (Table 6). I expected broad coverage of all resource categories in this type of literature, as administration should deal with all aspects of the fisheries and wildlife resource.

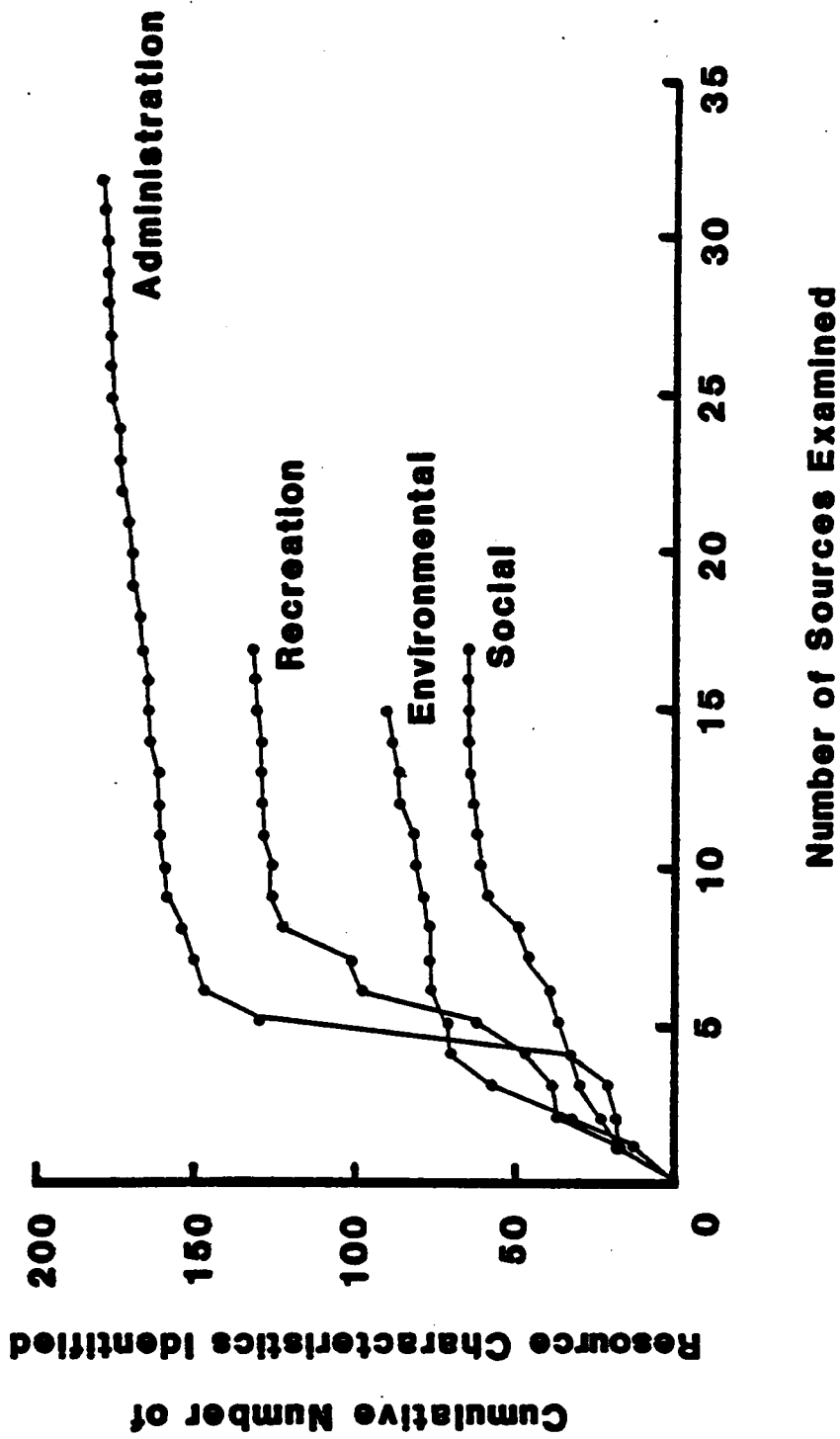


Fig. 5. Diminishing returns method for determining the number of sources to be examined for framework development.

Table 6. Number of resource characteristics identified in each source type.

	Source Type			
	Administrative	Environmental	Recreation	Social Assessment
People				
Inputs	6	7	10	6
Processes	16	6	15	6
Outputs	15	7	18	5
Impacts	15	9	17	10
Total	52	29	60	27
Populations				
Inputs	3	2	3	0
Processes	6	6	2	1
Outputs	6	6	6	1
Impacts	3	5	2	2
Total	18	19	13	4
Habitat				
Inputs	2	5	5	2
Processes	5	6	4	2
Outputs	4	4	3	1
Impacts	2	3	5	2
Total	13	18	17	7
Administration				
Inputs	8	4	5	11
Processes	14	6	7	8
Outputs	1	1	2	4
Impacts	2	1	0	2
Total	25	12	14	25
Grand Total	108	78	104	63

All resource characteristics identified in the literature search are listed in Table 7. I identified 149 resource characteristics. Some resource characteristics are included in more than one category-component combination, listed as both inputs and outputs. This is due to the dynamic nature of the fisheries and wildlife resource. For example, as Driver (1985) noted, the animals produced in wildlife management activities become inputs to future production of wildlife and recreation opportunities. The most well-represented resource category was People, having 63 characteristics, followed by Administration (36), Populations (25), and Habitat (25). The greatest number of characteristics identified were Processes (47), followed by Outputs (37), Impacts (33), and Inputs (32). Individual characteristics included in the final framework are explained in greater detail later in this chapter.

The most frequently reported resource characteristics in each source type are listed in Table 8. Frequency of mention in each source type and the number of source types in which a characteristic was included were criteria used to determine whether or not a resource characteristic would be included in the final framework.

Table 9 presents the matrix of resource characteristics, the final fisheries and wildlife framework. For later use in categorizing indicators, I assigned numbers to rows and letters to columns as indicated. I also assigned numbers to each characteristic within each matrix cell. For example, "User Characteristics" can be referred to as Resource Characteristic 1A-2 (row 1, column A, cell item 2). Within each cell, resource characteristics are listed in the order in which they were chosen

Table 7. All resource characteristics identified by resource category and component.

People		
Inputs	Processes	Outputs
User Preferences	Law Enforcement	Recreation Opportunities: Type
User Expectations	Providing Campsites	Recreation Opportunities: Quantity
Demand: Type of Experience	Providing Facilities	Recreation Opportunities: Quality
Demand: User Quantity	Providing Access	Trophy Acquisition
User Fees	Providing Trails	Beating Safety
Costs to Users	Interpretation Activities	Recreation Proximity to Users
User Characteristics	Education Activities	Research Results: People
Volunteers: Characteristics	Providing Information to Users	Nonconsumptive Use: Quantity
Volunteers: Value	Providing Landowner Assistance	Nonconsumptive Use: Quality
Private Sector Activities	Providing Public Input Opportunities	Consumptive Use: Type
	Research: People	Consumptive Use: Quantity
	Out-of-State Promotions	Consumptive Use: Quality
	Providing Handicap Access	Out-of-State Use: Quantity
	Public Relations	Participation Frequency
	Extension Activities	Commercial Opportunities
	Boat Safety Inspection	Hunter Safety
	Search and Rescue Operations	Resource Accessibility
	Providing Native American Access	User Knowledge/Awareness
		Tournaments/Competition
		Agency Perception
		Psychological Benefits
		Societal Benefits
		User Conflicts
		Economic Influences
		Public Health
		Property Values
		Industry Attraction
		Nature Appreciation
		Overcrowding
		Catch-Release Ethic
		Ethical Conduct of Users
		Organized Club Affiliation
		Compliance With Laws
		Users Police Own Ranks
		Agency-University Cooperation

Table 7. All resource characteristics identified by resource category and component (continued).

Populations	
Inputs	Outputs
<p><u>Processes</u></p> <p>Steeking</p> <p>Research: Populations</p> <p>Population Manipulation</p> <p>Animal Rehabilitation</p> <p>Damage Control</p> <p>Species Introductions</p> <p>Aquaculture</p> <p>Inventory</p>	<p><u>Impacts</u></p> <p>Damage/Depredation</p> <p>Resource Utilization</p> <p>Wildlife Hazards</p> <p>Effects on Unmanaged Species</p> <p>Gene Pool Values</p> <p>Threatened/Endangered Species</p> <p>Harvest Efficiency</p>
<p>Populations: Type</p> <p>Populations: Quantity</p> <p>Populations: Requirements</p> <p>Populations: Distributions</p>	<p>Populations: Type</p> <p>Populations: Quantity</p> <p>Harvest: Quantity</p> <p>Harvest: Type</p> <p>Harvest: Quality</p> <p>Research Results: Populations</p>
Habitat	
Inputs	Outputs
<p><u>Processes</u></p> <p>Habitat Conversion</p> <p>Pollution</p> <p>Habitat Acquisition</p> <p>Research: Habitat</p> <p>Environmental Monitoring</p> <p>Habitat Manipulation</p>	<p><u>Impacts</u></p> <p>Site Modifications</p> <p>Environmental Impacts</p> <p>Preservation</p> <p>Ecosystem Values</p> <p>Scientific Study Potential</p> <p>Human Disturbance</p> <p>Mitigation of Habitat Changes</p>
<p>Holdings: Water</p> <p>Holdings: Land</p> <p>Water Quality</p> <p>Weather</p> <p>Air Quality</p>	<p>Habitat: Type</p> <p>Habitat: Quantity</p> <p>Habitat: Quality</p> <p>Reserves: Quantity</p> <p>Reserves: Type</p> <p>Research Results: Habitat</p> <p>Aesthetic Background</p>

Table 7. All resource characteristics identified by resource category and component (continued).

Administration			
Inputs	Processes	Outputs	Impacts
Holdings: Facilities	Rate Processing	Land Available for Recreation	Use of Agency Reports
Revenue	Personnel: Training	Multiple Use of Holdings	Political Influence
Agency Policies	Agency Legal Counsel	Articles/Reports	Personnel: Morale
Personnel: Quantity	Maintenance Activities	Personnel: Productivity	
Legislation	Intergency Cooperation	Personnel: Safety	
Personnel: Qualifications	Planning		
Personnel: Distribution	Construction Activities		
Personnel: Salaries	Professional Activities		
Personnel: Job Security	Personnel: Interactions		
Personnel: Minorities	Lobbying Activities		
Personnel: Working Hours	Purchasing/Office		
Equipment	Engineering		
Governing Commission	Personnel Awards		
	Rules/Regulations		
	Expenditures		

according to the decision criteria. The particular criterion by which a characteristic was included is listed in parentheses after the characteristic description. Decision criteria numbers are those listed in the Methods section of this chapter. For example, Resource Characteristic 1A-2, User Characteristics, was included based on decision criterion 1, that it was mentioned in at least 10% of sources in each of the four source types. Characteristic 4D-3, Political Influence, was included based on decision criterion 9. It was mentioned in only one source type.

Those characteristics with "(sub)" listed as the decision criterion were characteristics which were not included in the framework based on the nine explicit decision criteria. I included these seven additional characteristics for subjective reasons. Law Enforcement (2A-6) was included as being an important function of state agencies. Because it was mentioned in all four source types it would have been included in the matrix under decision criterion 3, but five characteristics had already been identified using the first two criteria. Research: People (2A-7) was included as an important but underemphasized element of resource management (Snepenger and Ditton 1985).

Animal Rehabilitation (2B-6) was included as being a characteristic of future importance (Fraser and Moss 1985). Rules and Regulations (2D-6) was also included as being of increasing importance (e.g., Smoller and Schenborn 1984). Nonconsumptive Use: Quantity (3A-6) was included as currently important but underemphasized. Nonconsumptive uses outnumber consumptive uses of the wildlife resource (USDI and USDC 1982). Habitat Quality (3C-6) was included as an under-represented characteristic.

Table 8. Frequency with which resource characteristics are reported in each source type.

Environmental (N=15)	Social Assessment (N=17)
Ecosystem Values (60.0X)	Revenue (41.2X)
Habitat: Quantity (53.3X)	Personnel: Qualifications (41.2X)
Threatened/Endangered Species (46.7X)	Expenditures (41.2X)
Populations: Type (46.7X)	Public Relations (41.2X)
Populations: Quantity (46.7X)	User Characteristics (35.3X)
Pollution (46.7X)	Recreation Opportunities: Quantity (35.3X)
Water Quality (46.7X)	User Expectations (29.4X)
Demand: User Quantity (46.7X)	Demand: User Quantity (29.4X)
Habitat Acquisition (40.0X)	Personnel: Quantity (29.4X)
Reserves: Quantity (40.0X)	Consumptive Use: Quantity (29.4X)
Habitat Conversion (33.3X)	Nonconsumptive Use: Quantity (29.4X)
Research: Habitat (33.3X)	Agency Support/Perception (29.4X)
Recreation Opportunities: Quantity (33.3X)	51 Other Characteristics (<25.0X)
Habitat: Type (33.3X)	
Harvest: Quantity (33.3X)	
Populations: Distribution (26.7X)	
Research: Populations (26.7X)	
Population Manipulation (26.7X)	
60 Other Characteristics (<25.0X)	

Table 8. Frequency with which resource characteristics are reported in each source type (continued).

Administrative (N=32)	Recreation (N=17)
Harvest: Quantity (59.4x)	Psychological and Personal Benefits (64.7x)
Harvest: Type (59.4x)	Recreation Opportunities: Type (58.8x)
Consumptive Use: Quantity (53.1x)	Harvest: Quantity (58.8x)
Population Manipulation (58.0x)	Consumptive Use: Quantity (52.9x)
Demand: Type of Experience (48.6x)	Costs to Users (47.1x)
Demand: User Quantity (48.6x)	Harvest: Type (41.2x)
Habitat Manipulation (48.6x)	User Characteristics (35.3x)
Recreation Opportunities: Type (48.6x)	Recreation Opportunities: Quantity (35.3x)
Recreation Opportunities: Quantity (37.5x)	Participation Frequency (35.3x)
Providing Information to Users (34.4x)	User Expectations (29.4x)
Habitat: Quantity (34.4x)	Holdings: Facilities (29.4x)
Populations: Quantity (31.2x)	Water Quality (29.4x)
Consumptive Use: Type (31.2x)	Revenue (29.4x)
Recreation Opportunities: Quality (28.1x)	Private Sector Activities (29.4x)
Providing Access (28.1x)	Habitat: Type (29.4)
Planning (28.1x)	Habitat: Quantity (29.4x)
Populations: Requirements (28.1x)	Recreation Proximity to People (29.4x)
Holdings: Land (25.0x)	Societal Benefits (29.4x)
Education: Activities (25.0x)	User Conflicts (29.4x)
Providing Public Input Opportunities (25.0x)	Preservation (29.4x)
Nonconsumptive Use: Type (25.0x)	Nature Appreciation (29.4x)
Research Results: Populations (25.0x)	83 Other Characteristics (<25.0x)
86 Other Characteristics (<25.0x)	

Wildlife is affected not only by the quantity of habitat available, but also the quality. Finally, User Conflicts (4A-6) was included as an issue of future importance since the human population continues to increase but the resource base does not.

The fisheries and wildlife resource framework

The fisheries and wildlife resource framework lists the important resource characteristics necessary to consider in a comprehensive fisheries and wildlife indicator system. These are not the indicators themselves, but rather the topics of information for which indicators (described in Chapter 4) were identified.

Of the 149 resource characteristics identified, I chose these 82 to be included in the fisheries and wildlife resource framework. All cells are not represented equally. For example, Impacts-Administration (4D) contains 3 characteristics, whereas Processes-People (2A) contains 7 characteristics. This reflects (1) the availability of information in these areas (e.g., only 3 characteristics were identified for cell 4D) and (2) my decisions about what should be included in the framework. For example, characteristics 2A-6 and 2A-7 were included based on my subjective judgments as explained earlier.

Matrix cell 1A (Table 9) includes inputs in the People category. Demand: Quantity (1A-1) refers to the number of users or potential users of the fisheries and wildlife resource. User Characteristics (1A-2) refers to demographic descriptions of resource users. User Expectations

Table 9. Fisheries and wildlife resource framework matrix.

RESOURCE CATEGORIES				
RESOURCE COMPONENTS	PEOPLE (A)	POPULATIONS (B)	HABITAT (C)	ADMINISTRATION (D)
INPUTS (1)	1. Demand: Quantity (1) X	Populations: Quantity (2)	Holdings: Land (2)	Revenue (1)
	2. User Characteristics (1)	Populations: Requirements (2)	Holdings: Water (3)	Legislation (1)
	3. User Expectations (2)	Populations: Distributions (4)	Water Quality (5)	Holdings: Facilities (3)
	4. Demand: Type (2)	Populations: Type (9)	Air Quality (5)	Personnel: Quantity (4)
	5. Costs to Users (5)			Personnel: Qualifications (5)
PROCESSES (2)	1. Education Activities (1)	Research: Populations (2)	Habitat Acquisitions (2)	Interagency Cooperation (1)
	2. Information to Users (1)	Population Manipulation (2)	Research: Habitat (2)	Planning (1)
	3. Providing Access (2)	Stocking (5)	Habitat Manipulation (2)	Personnel: Training (3)
	4. Lender Assistance (2)	Damage/Depredation Control (6)	Habitat Conversion (3)	Expenditures (3)
	5. Public Input Opportunities (2)	Species Introductions (6)	Pollution (6)	Data Processing (5)
	6. Law Enforcement (sub)	Animal Rehabilitation (sub)		Rules/Regulations (sub)
	7. Research: People (sub)			
OUTPUTS (3)	1. Rec. Opportunities: Quant. (1)	Harvest: Quantity (2)	Habitat: Quantity (2)	Land Available for Recreation (5)
	2. Consumptive Use: Quantity (1)	Harvest: Type (2)	Research Results: Habitat (2)	Articles/Reports (8)
	3. User Knowledge/Awareness (1)	Populations: Quantity (2)	Habitat Types (3)	Multiple Use of Holdings (9)
	4. Rec. Opportunities: Type (2)	Research Results: Populations (2)	Reserves: Quantity (6)	Personnel: Productivity (9)
	5. Consumptive Use: Type (2)	Populations: Type (2)	Reserves: Type (6)	Personnel: Safety (9)
	6. Nonconsumptive Use: Quant. (sub)		Habitat: Quality (sub)	
IMPACTS (4)	1. Economic Influences (1)	Damage/Depredation (1)	Preservation (3)	Personnel: Morale (5)
	2. Agency Perception (3)	Threatened/Endangered Species (5)	Ecosystem Values (6)	Use of Agency Reports (6)
	3. Organized Club Affiliation (3)	Resource Utilization (6)	Scientific Studies (6)	Political Influence (9)
	4. Personal Benefits (5)	Effects on Nonmanaged Species (6)	Environmental Impacts (6)	
	5. Societal Benefits (5)	Wildlife Hazards (9)		
	6. User Conflicts (sub)			

XNumbers in parentheses indicate decision criteria used to include each characteristic in the matrix.

(1A-3) refers to public expectations about the benefits to be derived from the resource and its use. Demand: Type (1A-4) refers to the type of experience demanded or desired by the public. Finally, Costs to Users (1A-5) includes costs that people incur in order to use and enjoy the resource.

Matrix cell 2A includes processes or activities relating to people. Education Activities (2A-1) refers to agency activities involved with formal education programs and providing factual materials on conservation and resource management. Providing Information to Users (2A-2) includes all activities relating to informing the public of agency activities, regulations, and tips on using the resource. Providing Access (2A-3) refers to activities designed to make the resource more accessible to users. Providing Landowner Assistance (2A-4) refers to activities directed at enabling landowners to understand and practice desirable fisheries and wildlife management techniques. Providing Public Input Opportunities (2A-5) includes activities focused on stimulating members of the public to communicate their wishes on resource issues. Law Enforcement (2A-6) refers to activities focused on ensuring fisheries and wildlife agency rules and regulations are upheld. Research: People (2A-7) includes research activities that are focused on the users of the resource.

Matrix cell 3A addresses outputs that are produced for people. Recreation Opportunities: Quantity (3A-1) refers to general recreation opportunities provided and/or used in conjunction with or secondary to fisheries and wildlife resources (e.g., camping, boating, picnicking). Consumptive Use: Quantity (3A-2) includes uses directly relating to the

consumptive use of the resource. User Knowledge/Awareness (3A-3) refers to the understanding people have of the resource and its use. Recreation Opportunities: Type (3A-4) includes the type of opportunities that are available in which to use the fisheries and wildlife resource (e.g., public vs. private). Consumptive Use: Type (3A-5) refers to the range of different consumptive opportunities provided and used. Nonconsumptive Use: Quantity (3A-6) includes uses directly relating to the nonconsumptive use of the resource.

Matrix cell 4A addresses impacts (positive or negative) from the fisheries and wildlife resource that affect people. Economic influences (4A-1) includes economic effects that stem from resource management and use. Agency Perception (4A-2) refers to public attitudes toward the management agency and its actions. Organized Club Affiliation (4A-3) includes activities in organizations which are involved with fisheries and wildlife resources. Personal Benefits (4A-4) refers to benefits individuals receive from using or knowing about the resource. Societal Benefits (4A-5) refers to benefits accruing to society as a result of people's use and knowledge of fisheries and wildlife resources. User Conflicts (4A-6) relates to situations in which two or more users come into conflict regarding use of the resource.

Matrix cell 1B addresses population inputs. Populations: Quantity (1B-1) refers to number of animals in a given population. This characteristic differs from 3B-3 in addressing trends in population sizes, or population size at the end of the last management year. Thus, potentially, an indicator value from 3B-3 for last year may be the same as 1B-1 for this year. Outputs at the end of one management cycle become the

inputs of the next. Populations: Requirements (1B-2) refers to the extent to which requirements of various populations are known. Populations: Distribution (1B-3) refers to the distribution of given species within a state. Populations: Type (1B-4) includes the variety of species occurring in a state.

Matrix cell 2B includes processes involving fisheries and wildlife populations. Research: Populations (2B-1) refers to research activities involving a study of animal populations. Population Manipulation (2B-2) includes management activities directly involved with manipulating individuals or groups of animals of given species. Stocking (2B-3) involves activities associated with supplementing fisheries and wildlife population numbers. Damage/Depredation Control (2B-4) involves activities performed in relation to damage caused by fish and wildlife. Species Introductions (2B-5) involves activities dealing with introducing non-native species or extirpated species into a state. Animal Rehabilitation (2B-6) refers to activities involved with caring for injured wildlife.

Matrix cell 3B includes outputs produced from fisheries and wildlife populations. Harvest: Quantity (3B-1) includes all harvested animals. Harvest: Type (3B-2) refers to characteristics of harvest activities other than the quantity of animals harvested. Populations: Quantity (3B-3) is similar to 1B-1 as noted, and refers to the size of fisheries and wildlife populations at the end of a management cycle or due to management practices during the current year. Research Results: Populations (3B-4) refers to the results of research activities undertaken to study fisheries and wildlife populations. Populations: Type (3B-5) is similar

to 1B-4 and refers to the variety of species providing some type of opportunity to users of the resource.

Matrix cell 4B addresses impacts to or caused by fisheries and wildlife populations. Damage/Depredation (4B-1) includes undesirable people-wildlife interactions. Threatened/Endangered Species (4B-2) refers to concerns relative to classified species on the state or federal level. Resource Utilization (4B-3) includes descriptions of the extent to which fisheries and wildlife populations are used. Effects on Non-managed Species (4B-4) refers to impacts on species not specifically managed through agency activities but which may be affected by management practices. Wildlife Hazards (4B-5) includes occurrences in which the presence of wildlife may cause problems of safety for humans.

Matrix cell 1C includes inputs related to habitat. Holdings: Land (1C-1) and Holdings: Water (1C-2) refer to quantity and ownership types of land and aquatic areas that may be potentially available as fisheries and wildlife habitat. Water Quality (1C-3) and Air Quality (1C-4) address environmental quality issues on the state level.

Matrix cell 2C addresses processes involved with fisheries and wildlife habitat. Habitat Acquisition (2C-1) includes activities related to acquiring lands for use as fisheries and wildlife habitat. Research: Habitat (2C-2) refers to activities involved in studying fisheries and wildlife habitats. Habitat Manipulation (2C-3) includes management activities directly involving some manipulation of habitat. Habitat Conversion (2C-4) includes activities in which habitat is changed from one type to another. Pollution (2C-5) refers to management activities undertaken as a result of environmental pollution.

Matrix cell 3C includes outputs related to habitat. Habitat: Quantity (3C-1) is related to 1C-1 and 1C-2, but refers to habitat available and or managed for fisheries and wildlife at the end of a management cycle. This is another situation in which outputs later become inputs. Research Results: Habitat (3C-2) refers to results of research studies dealing with habitat. Habitat: Types (3C-3) includes the variety of habitats occurring in the state. Reserves: Quantity (3C-4) is similar to 3C-1 but refers to areas that are reserved from other uses specifically to maintain natural vegetation, wildlife, or unusual environments. Reserves: Type (3C-5) includes descriptions of the types of reserves occurring in a state. Habitat: Quality (3C-6) refers to the actual suitability of habitat for fisheries and wildlife uses.

Matrix cell 4C addresses impacts relating to habitat. Preservation (4C-1) refers to results of habitat management activities which preserve areas of habitat for future benefits to fisheries and wildlife resources. Ecosystem values (4C-2) refers to characteristics of the entire ecosystem, such as community diversity. Scientific Study Potential (4C-3) refers to research opportunities provided by the fisheries and wildlife resource which are not specifically agency research activities. Environmental Impacts (4C-4) refers to effects humans have on fisheries and wildlife habitat.

Matrix cell 1D includes inputs of administration. Revenue (1D-1) includes all sources of agency revenue. Legislation (1D-2) refers to directions given to agency administration through the legislative process. Holdings: Facilities (1D-3) refers to facilities owned for use in some resource-related capacity. Personnel: Quantity (1D-4) and Person-

nel: Qualifications (1D-5) refer to the number of agency employees and their qualifications.

Matrix cell 2D addresses activities related to administration. Interagency Cooperation (2D-1) refers to activities in which a fisheries and wildlife agency cooperates with other administrative or management units. Planning (2D-2) includes any planning activities undertaken by a state agency. Personnel: Training (2D-5) refers to training activities made available to agency employees. Expenditures (2D-4) refers to agency spending. Data Processing (2D-5) includes general data-handling and computing activities of agencies. Rules/Regulations (2D-6) refers to agency policy-setting and rule-making intended to guide the use of the resource.

Matrix cell 3D includes outputs related to the administration of resources. Land Available for Recreation (3D-1) refers to the quantity and type of land accessible to users, provided by agency administration or other owners. Articles/Reports (3D-2) refers to the type and quantity of reports produced as a result of agency activities. Multiple Use of Holdings (3D-3) refers to agency holdings managed for more than one type of use. Personnel: Productivity (3D-4) includes the amount and/or quality of work performed by agency personnel. Personnel: Safety (3D-5) refers to the safety record of agency employees while on the job.

Matrix cell 4D addresses impacts related to agency administration. Personnel: Morale (4D-1) refers to influences on the morale of agency personnel. Use of Agency Reports (4D-2) refers to actual use of documents produced by an agency or its employees. Political Influence (4D-3) in-

cludes agency influence on other decision processes resulting from agency activities or reputation.

Discussion

The 16 cells of the matrix provide the organizational framework for the indicator system. The framework serves as the basis for categorizing the universe of concerns and responsibilities involved in fisheries and wildlife resource management. Although many more People resource characteristics were identified in the literature search than Administration, Habitat, or Populations characteristics (Table 7), I chose to limit the number of characteristics included in each cell (1) to achieve a balance within the framework and (2) to avoid emphasizing greatly one cell over another, in the belief that all categories of the resource are important and should be represented in the indicator system. Even with this limiting criterion, there are more People characteristics (24) included in the framework than Populations (20), Habitat (19), or Administration (19). Cells contain a minimum of 3 resource characteristics and a maximum of 7 with an average of 5.1 per cell. Fewest resource characteristics were identified for Impacts-Administration. This may indicate a lack of concern for impacts involved in fisheries and wildlife administration, or may indicate the difficulty of analyzing concepts such as administration impacts.

The resource framework is intended to represent the current and near-future concerns of fisheries and wildlife professionals. Over time, additions may be made to the framework to include explicitly resource

characteristics which become important in the future. Of the 149 characteristics identified, 82 are included in the resource framework. Some of those that were not included may grow in importance and may eventually be incorporated into the framework (e.g., Public Sector Activities). Others not identified in the literature search may be added to the framework based on future developments in fisheries and wildlife management which were not foreseen in the literature sources I consulted. This resource framework served as the basis for identifying and selecting fisheries and wildlife indicators described in the next chapter.

CHAPTER 4: FISHERIES AND WILDLIFE INDICATORS

I used the fisheries and wildlife resource framework described in Chapter 3 as the basis for categorizing potential fisheries and wildlife indicators. For each resource characteristic within each cell of the framework, I identified a series of indicators (Fig. 6). An indicator, as defined earlier, is a single measurement of the resource reported in an unaggregated form. Indicators are specific variables which describe the status of each resource characteristic listed in the fisheries and wildlife framework. The focus of this indicator system is on annual measures for state-level application, not on local areas or management districts. I therefore included in the collection of indicators only those relevant to state-level concerns. Many of these can be adjusted to address district or regional management. Local data for districts may be gathered instead of state-level data, or data from a number of states may be aggregated for a regional representation.

In this chapter, I describe the methods used to identify and select relevant indicators. I also present all indicators identified, discuss the general characteristics of indicators for each of the 16 cells of the resource framework, and describe the characteristics of the recommended indicator system.

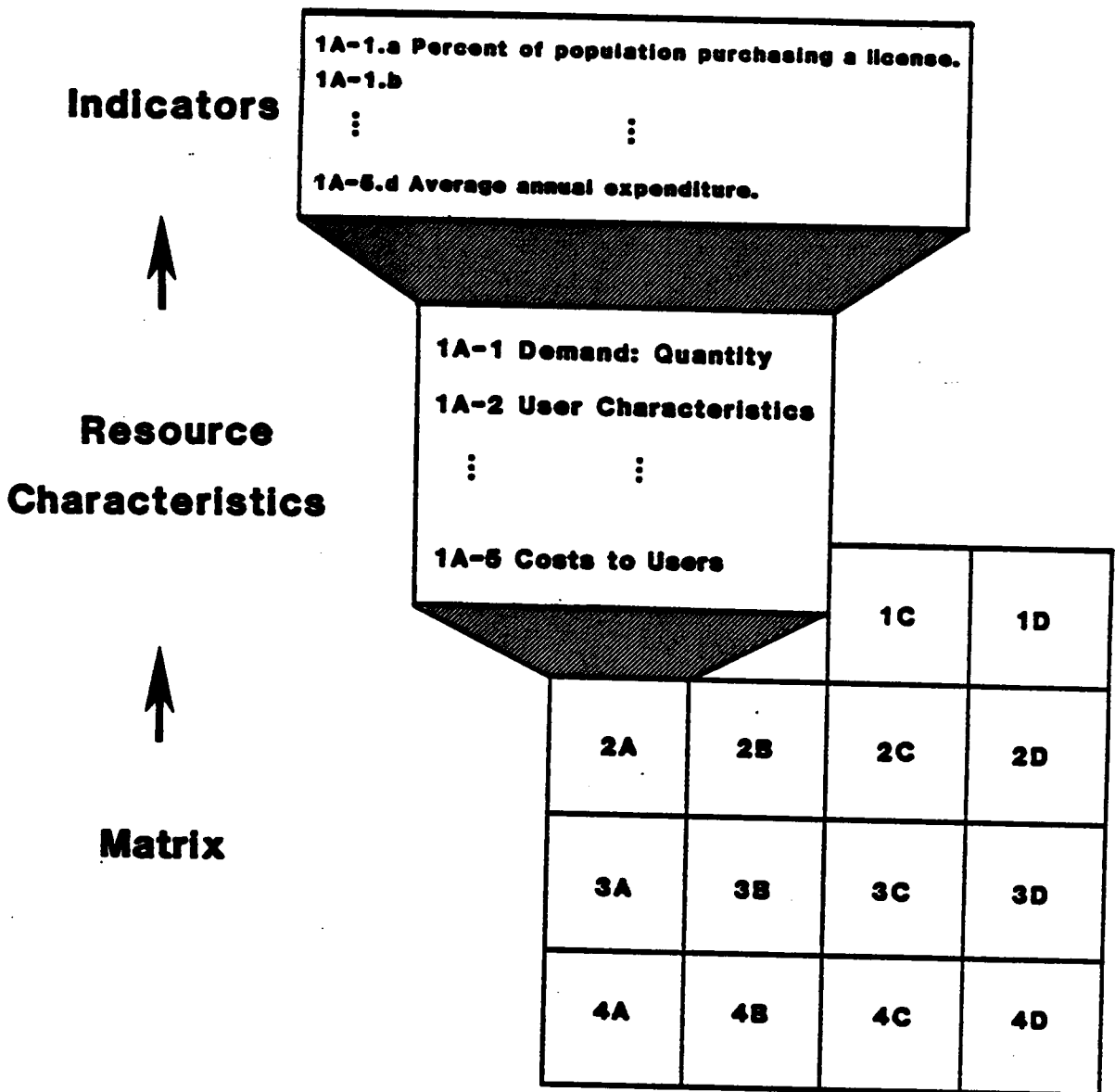


Fig. 6. Indicator identification process showing progression from empty fisheries and wildlife resource framework matrix, to selecting resource characteristics for each cell, to identifying indicators for each resource characteristic, using Inputs-People as an example.

Methods

I conducted a detailed search of resource-related literature to identify potential indicators of state-level concern for each of the 82 resource characteristics identified in the resource framework (Table 9). I searched three groups of literature. First, I searched the most recent two years (usually 1984 and 1985) of selected resource-related journals (Table 10). These journals were selected on the basis of frequency of citation in fisheries literature (Nielsen and Summers 1979) and wildlife literature (Hein 1967), as well as on my own familiarity with natural resource and social assessment literature. Second, I searched the most recent two years of selected indexes and abstracts for which annual compilations were available (usually 1983 and 1984). These sources were chosen on the basis of the types of literature they are designed to index (Table 11). With these two strategies, I targeted the most recent 4-5 years of resource-related literature. Third, I searched any potential sources identified incidentally during this and other phases of my research.

I used three criteria to describe each indicator identified in the literature, based on suggestions from the Council on Environmental Quality (1981) and Davis (1984). The first criterion, that of appropriateness, refers to how directly an indicator provides annual information on a given resource characteristic in the framework. I judged appropriateness as low, moderate, or high. A highly appropriate indicator measures a resource characteristic directly (e.g., commercial landings as a

Table 10. Recent journals searched for fisheries and wildlife indicators.

American Midland Naturalist
Biological Conservation
California Fish and Game
Canadian Journal of Fisheries and Aquatic Sciences
Current Fishery Statistics
Ecological Monographs
Ecology
Environmental Conservation
Fisheries
Journal of Applied Ecology
Journal of Environmental Management
Journal of Leisure Research
Journal of Wildlife Management
Land Economics
Marine Fisheries Review
New York Fish and Game
North American Journal of Fish Management
Proc. Southeastern Assoc. of Fish and Wildlife Agencies
Social Indicators Research
The Annals: Am. Acad. of Political and Social Science
The Environmental Professional
Transactions of the American Fisheries Society
Trans. of the North Am. Wildlife and Nat. Resources Conf.
Trends (Park Practice Program, Washington, D.C.)
Wildlife Society Bulletin

Table 11. Abstracts and indexes searched for indicator literature.

Aquatic Sciences and Fisheries Abstracts

Biological Abstracts

Environment Index/Abstracts

Science Citations Index

Social Science Citations Index

Social Sciences Index

Sport Fishery Abstracts

Wildlife Review

measure of commercial harvest). Indicators judged moderate or low in appropriateness measure a resource characteristic indirectly. Classification as low or moderate depended on the strength of the relationship between the indicator and the resource characteristic.

The second criterion I used was that of availability, also classified as high, moderate, or low. A highly available indicator is one found in routinely collected agency data files, accessible government documents, or research literature. I assigned a moderate rating to indicators for which existing data would have to be manipulated substantially in some way, or for which present data collection techniques would need to be changed to a different format or method. If new data collection methods would need to be developed and instituted, I assigned a rating of low availability to the indicator.

The third criterion describes the type of source in which the indicator appeared. I classified each source numerically as follows: (1) agency documents which describe an indicator in use; (2) reports demonstrating the validity or biases of a particular indicator, or describing research which has been performed on a particular indicator; (3) reports in the literature which offer no supporting data, but simply suggest that a particular indicator may be useful for agencies to measure; and (4) my own suggestions for indicators for resource characteristics for which I could identify no suitable indicators in the literature.

After all sources were searched, I compiled a list of all indicators identified for each resource characteristic. From this master list, I selected a subset of indicators which I recommend be monitored by state fisheries and wildlife management agencies. I selected these indicators

from the master list in three stages. First, I selected indicators judged both highly appropriate and highly available for each resource characteristic. Second, if fewer than two indicators were selected for each characteristic by this method, I chose additional indicators based on their appropriateness and availability. Highly appropriate indicators were chosen before moderately appropriate indicators, then the most available indicators within these classifications were selected. Each resource characteristic, therefore, had at least two indicators selected. Third, for certain resource characteristics, I recommended additional indicators which may be low in availability, but which have the potential of providing very useful information once they are monitored. The Appendix contains descriptions of each of these recommended indicators and lists those not selected from the master list with the sources in which they were located.

Results and discussion

I identified a total of 377 indicators (Table 12). The resource category of People contains the most indicators identified (133), followed by Habitat (88), Populations (86), and Administration (70). This emphasis on the fisheries and wildlife resource and its use rather than on administrative concerns begins to address the recommendations listed in Chapter 2, namely that resource and public use concerns be given more coverage. In my analysis of state agency annual reports (reviewed in Chapter 2), I found a definite emphasis on administrative and economic information, and comparatively little reported on public use of fisheries

and wildlife resources. The indicators described here are a step toward addressing public involvement issues more thoroughly.

The resource component of Processes contains the most indicators (120), followed by Outputs (114), Inputs (74), and Impacts (69). As I discussed in Chapter 3, traditional management concerns have focused on inputs and processes. Processes are theoretically the easiest component to report. Relatively little effort is required to keep track of actual activities and report these as processes. The relatively high number of output indicators identified begins to incorporate the "planning" focus described in Chapter 3. With a sufficient number of processes and outputs identified and measured, it may be possible in the future to add predictive power to management planning by relating a given level of processes to a desired level of outputs.

The matrix cells with the greatest number of indicators identified are 2A (Processes-People) and 3A (Outputs-People). Within each of these cells, the resource characteristics with the most indicators deal with information and education, or law enforcement. These are two areas which traditionally have been well-reported (see Chapter 2) and for which many potential indicators appeared in the literature. The matrix cell with the fewest indicators is 4D (Impacts-Administration). This cell also contains the fewest resource characteristics identified in Chapter 3.

Fifty-eight percent of the indicators were cited in at least one type-1 source (agency documents describing an indicator in use) (Table 13). The resource component of Processes contains the highest percentage of indicators cited in agency documents. Processes are actual activities

Table 12. Number of indicators identified for each resource characteristic.

Resource Components	Resource Categories				
	People (A)	Populations (B)	Habitat (C)	Administration (D)	Totals
Inputs (1)	1.	8	4	3	8
	2.	6	3	3	2
	3.	2	4	8	3
	4.	4	2	5	2
	5.	4	-	-	3
Totals	24	13	19	18	74
Processes (2)	1.	4	4	3	5
	2.	13	5	4	2
	3.	7	8	4	3
	4.	5	5	5	2
	5.	2	3	7	4
	6.	10	4	-	7
	7.	4	-	-	-
Total	45	29	23	23	120
Outputs (3)	1.	5	11	6	3
	2.	9	6	4	4
	3.	10	6	3	2
	4.	3	3	5	7
	5.	3	2	3	5
	6.	9	-	5	-
Total	39	28	26	21	114
Impacts (4)	1.	6	2	7	3
	2.	8	4	2	2
	3.	2	5	2	3
	4.	2	2	9	-
	5.	5	3	-	-
	6.	2	-	-	-
Total	25	16	20	8	69
Totals	133	86	88	70	377

of agencies, and are therefore the most likely component to be found in agency documents for reasons discussed above. The component of Impacts contains the lowest percentage of indicators cited in agency documents. This demonstrates the lack of present monitoring capabilities for these concerns. Included in the agency documents examined for potential indicators were planning reports. The percent of Output indicators cited in source type 1, especially for Populations, may be accounted for by the emphasis on outputs in these documents. The relatively low percent of Input indicators cited in agency documents may reflect the difficulty in distinguishing inputs and outputs due to the dynamic nature of these resources, where outputs one year become inputs the next.

Fifty-five percent of all indicators in the Population and Habitat categories and 62% of indicators in the Administration category were cited in agency documents. This agrees with my results in Chapter 2 about the content of annual reports. I found that annual reports emphasized administrative information rather than resource information. Sources other than agency documents were particularly valuable for identifying habitat indicators.

Matrix cell and indicator characteristics

There is a significant relation between resource component and the number of highly available, highly appropriate indicators ($\chi^2=48.42$, d.f.=3, $P<0.01$). The most well-represented cells in terms of highly available and highly appropriate indicators address the Process component

Table 13. Percent of indicators cited in source type 1 (agency documents).

Resource Components	Resource Categories				Total
	People (A)	Populations (B)	Habitat (C)	Administration (D)	
Inputs (1)	54%	69%	16%	61%	49%
Processes (2)	73%	83%	61%	83%	75%
Outputs (3)	67%	82%	35%	55%	61%
Impacts (4)	32%	44%	30%	25%	33%
Total	60%	73%	36%	62%	58%

of fisheries and wildlife management (Table 14). Indicators for other components are relatively unavailable. Through time, much of this information may become more readily available as agency priorities and responsibilities change and expand and as efforts are made to collect regularly information on the spectrum of agency responsibilities.

Resource category is also related significantly to the number of highly available, highly appropriate indicators ($\chi^2=20.83$, d. f.=3, $P<0.01$). The most well-represented cells in terms of highly available and highly appropriate indicators are those which address administrative resource characteristics (Table 15). As discussed in Chapter 2, administrative information is emphasized in annual reports, so data already exist for indicators in this category. Considering the total number of indicators identified for the category People, relatively few are highly available and highly appropriate. This demonstrates the current lack of monitoring capabilities representing people's demand for and actual use of fisheries and wildlife resources.

There is a significant relation between individual matrix cells and the number of highly available, highly appropriate indicators ($\chi^2=84.34$, d. f.=15, $P<0.01$) (Table 16). Inputs, Outputs, and Impacts dealing with People and Inputs-Populations contain the lowest percentage of highly available and highly appropriate indicators.

All indicators identified are presented by matrix cell in the master lists in Tables 17-32. Each indicator is listed with its resource characteristic identification number (e. g. , 1A-1) and the ratings assigned

Table 14. Number of highly available and highly appropriate indicators in each resource component.

Resource Components	Number of Indicators		
	Highly Available and Highly Appropriate	Others	Total
Inputs (1)	23	51	74
Processes (2)	84	36	120
Outputs (3)	35	79	114
Impacts (4)	24	45	69
Total	166	211	377

Table 15. Number of highly available and highly appropriate indicators in each resource category.

Resource Category	Number of Indicators		
	Highly Available and Highly Appropriate	Others	Total
People (A)	43	90	133
Populations (B)	39	47	86
Habitat (C)	38	50	88
Administration (D)	46	24	70
Total	166	211	377

Table 16. Number of highly available and highly appropriate indicators in each matrix cell.

Matrix Cell	Number of Indicators		
	Highly Available and Highly Appropriate	Others	Total
1A: Inputs-People	3	21	24
2A: Processes-People	30	15	45
3A: Outputs-People	7	32	39
4A: Impacts-People	3	22	25
1B: Inputs-Populations	2	11	13
2B: Processes-Populations	22	7	29
3B: Outputs-Populations	8	20	28
4B: Impacts-Populations	7	9	16
1C: Inputs-Habitat	5	14	19
2C: Processes-Habitat	16	7	23
3C: Outputs-Habitat	9	17	26
4C: Impacts-Habitat	8	12	20
1D: Inputs-Administration	13	5	18
2D: Processes-Administration	16	7	23
3D: Outputs-Administration	11	10	21
4D: Impacts-Administration	6	2	8
Total	166	211	377

for appropriateness and availability (i. e. , low, moderate, high). A more detailed description of each indicator is presented in the Appendix.

Matrix cell 1A, Inputs-People, is generally a homogeneous collection of indicators dealing with resource users and use for which relatively few highly available and highly appropriate indicators exist (Table 17). Most information that is highly available concerns consumptive use inputs. Nonconsumptive use inputs (e. g. , demand, characteristics, expectations) are not well represented. I identified no highly appropriate indicators for user demands. This would be a fertile area for future research. Demand indicators now available tend to be evaluations of actual use and participation, rather than measures of potential use, participation, and enjoyment (Davis and Seneca 1972, Hoekstra 1983). Demand indicators based on actual use are less than ideal because they depend on several assumptions (Outdoor Recreation Policy Review Group 1983): (1) that there is an equal distribution of recreation resources among the state population; (2) that people are doing what they want to be doing; and (3) that people have complete knowledge of the opportunities available to them. Because indicators in this cell relate so strongly to actual use, there are some similarities with indicators in cell 3A. The least available indicators in cell 1A address user expectations and type of experience demanded. Research is needed to develop easily implemented techniques which provide information for these indicators. Twelve indicators from this cell are included in the recommended indicator system.

Matrix cell 2A, Processes-People, is well-represented with many highly appropriate, highly available indicators (Table 18). This cell contains

Table 17. Fisheries and wildlife indicators master list, cell 1A: Inputs-People.

Resource Charact.	Indicator	Approp.	Avail.	Recommended
1A-1.a	Percent of population purchasing a harvest license.	M	H	X
1A-1.b	Percent of population donating to the nongame program.	M	H	X
1A-1.c	Number of applicants for each harvest license available.	M	H	
1A-1.d	Per capita purchase of harvest licenses.	M	H	
1A-1.e	Number of harvest licenses sold.	M	H	
1A-1.f	Number of anglers and hunters, determined by survey.	M	M	
1A-1.g	Percent of population engaging in some form of resource use or enjoyment, determined by survey	M	M	X
1A-1.h	Number of days of hunting and fishing occurring annually.	M	L	
1A-2.a	Percent of resource users in each age group.	H	H	X
1A-2.b	Percent of resource users in each gender.	H	H	X
1A-2.c	Percent of resource users in each region of state.	H	M	X
1A-2.d	Percent of resource users in each educational bracket.	H	L	
1A-2.e	Percent of resource users in each income bracket.	M	L	
1A-2.f	Percent of resource users in each racial group.	H	L	
1A-3.a	Percent of resource users by reason for participation	H	L	X
1A-3.b	Percent of resource users in each attitude class.	M	L	X
1A-4.a	Percent of population preferring a given type of experience.	H	L	X

Table 17. Fisheries and wildlife indicators master list, cell 1A (continued).

Resource Charact.	Indicator	Approp.	Avail.	Recommended
1A-4.b	Percent of population desiring resource use opportunities within a given distance of their residence.	H	L	X
1A-4.c	Number of miles actually traveled by users to each type of resource use.	M	L	
1A-4.d	Percent of resource users using public lands.	L	L	
1A-5.a	Cost of harvest license, by type.	H	H	X
1A-5.b	Average annual expenditure per user for recreation involving the fisheries and wildlife resource.	H	L	X
1A-5.c	Average expenditure per trip for recreation involving the fisheries and wildlife resource.	H	L	
1A-5.d	Average daily expenditure for recreation trips involving the fisheries and wildlife resource.	H	L	

information, education, and law enforcement activities, all of which have been well-reported in the past. Indicators in this cell are relatively homogeneous, dealing with agency activities directly involving the public. This cell contains the greatest number of recommended indicators of all 16 cells. Thirty-one indicators are recommended, 30 of which are highly available and highly appropriate. The fewest indicators (2 each) are recommended for public input opportunities and research on users. The greatest number of indicators are recommended for law enforcement (7), information to users (5), providing access (5), and landowner assistance (5). The comparatively high availability of all indicators in this cell and the fact that this cell contains two additional resource characteristics account for the high number of recommended indicators from this cell.

Matrix cell 3A, Outputs-People, is a heterogeneous cell in terms of the availability of indicators (Table 19). Two characteristics, consumptive use quantity and user knowledge contain highly available indicators. Indicators for consumptive use quantity were found in many sources, demonstrating a great interest in as well as great availability of these data. Indicators representing the rest of the resource characteristics within this cell are relatively unavailable. These indicators address general and nonconsumptive recreation opportunities, as well as types of consumptive use occurring. Duplication exists between indicators in sections 1A and 3A. Generally, these duplicate indicators are moderately appropriate or available indicators of demand (for 1A) and highly appropriate or available indicators of actual opportunities used

Table 18. Fisheries and wildlife indicators master list, cell 2A: Processes-People.

Resource Charact.	Indicator	Approp.	Avail.	Recommended
2A-1.a	Number of workshops conducted for educational instruction.	H	H	X
2A-1.b	Number of requests received for speakers to make presentations at schools.	H	H	X
2A-1.c	Rating received by hunter education program.	H	H	X
2A-1.d	Percent of personnel time spent preparing curriculum development materials.	H	H	X
2A-2.a	Number of news releases written per year.	H	H	X
2A-2.b	Number of audio-visual productions completed per year.	H	H	X
2A-2.c	Number of information publications prepared.	H	H	X
2A-2.d	Number of information programs presented to the public.	H	H	X
2A-2.e	Percent of personnel time spent on information and education activities.	H	H	X
2A-2.f	Percent of information inquiries to the agency which were answered.	H	M	
2A-2.g	Number of times audio-visual productions were used.	H	M	
2A-2.h	Number of media interviews in which field personnel participated.	H	M	
2A-2.i	Number of news releases actually printed or broadcast.	H	L	
2A-2.j	Number of recipients of news releases.	M	H	
2A-2.k	Renewal rate for agency magazine subscriptions.	M	H	
2A-2.l	Percent of budget spent on agency promotions.	M	H	
2A-2.m	Volume of publication sales, in dollars.	M	H	

Table 18. Fisheries and wildlife indicators master list, cell 2A (continued).

Resource Character.	Indicator	Approp.	Avail.	Recommended
2A-3.a	Number of new access areas acquired or constructed.	H	H	X
2A-3.b	Total number of access areas maintained or under lease.	H	H	X
2A-3.c	Percent of budget spent on access site acquisition and development.	H	H	X
2A-3.d	Number of miles (km) of road controlled and maintained.	H	H	X
2A-3.e	Number of acres (ha) accessible through cooperative agency contracts with landowners.	H	H	X
2A-3.f	Percent of population living within a specified distance of recreation opportunities.	H	M	X
2A-3.g	Percent of landowners posting property against trespass.	H	L	
2A-4.a	Number of contacts with landowners to give technical assistance.	H	H	X
2A-4.b	Number of short courses offered to landowners regarding management practices.	H	H	X
2A-4.c	Number of cooperative agreements between agency and landowners for private land management.	H	H	X
2A-4.d	Number of management plans produced for landowner cooperators.	H	H	X
2A-4.e	Percent of personnel time devoted to landowner assistance.	H	H	X
2A-5.a	Number of formal public meetings held.	H	H	X
2A-5.b	Number of people attending public meetings.	H	H	X

Table 18. Fisheries and wildlife indicators master list, cell 2A (continued).

Resource Character.	Indicator	Approp.	Avail.	Recommended
2A-6.a	Number of licensed hunters and anglers per full-time enforcement officer.	H	H	X
2A-6.b	Number of public contacts by law enforcement officers.	H	H	X
2A-6.c	Number of arrests or citations issued.	H	H	X
2A-6.d	Number of convictions obtained per arrest.	H	H	X
2A-6.e	Amount of fines collected as a result of violation convictions.	H	H	X
2A-6.f	Percent of agency employees who are enforcement officers.	H	H	X
2A-6.g	Percent of agency budget devoted to law enforcement activities.	H	H	X
2A-6.h	Number of phone calls received reporting violations.	M	H	
2A-6.i	Number of times enforcement officers were called upon for witness testimony.	M	H	
2A-6.j	Average value of agent politeness scale as judged by resource users.	M	L	
2A-7.a	Amount of money committed to user-related research.	H	H	X
2A-7.b	Percent of personnel time spent on user-related research.	H	H	X
2A-7.c	Number of research studies addressing users.	M	H	
2A-7.d	Number of personnel assigned to user-related research.	M	H	

(for 3A). As discussed for cell 1A, few highly appropriate indicators of demand exist, so measures of actual use must be substituted. Eighteen indicators from this cell are included in the recommended indicator system.

Matrix cell 4A, Impacts-People, is a heterogeneous cell in terms of the number of indicators identified for each resource characteristic (Table 20). The fewest indicators (2 each) were identified for personal benefits, societal benefits, and user conflicts. Personal and societal benefits are notoriously difficult to assess. No simple, standard techniques have been developed to measure these characteristics (Peine et al. 1980). Potential indicators of user conflicts were difficult to locate in the literature, but may become more important as the resource base decreases and human use and understanding of the resource increases. Although potential indicators of agency perception and economic influences are relatively numerous, they are not widely available. In general, information on impacts relating to people is characterized by low availability. Fifteen indicators from this cell are included in the recommended indicator system.

Matrix cell 1B, Inputs-Populations, is related to cell 3B, Outputs-Populations. Indicators in 1B rely on information gathered in cell 3B (e.g., Populations: Quantity). This is a very homogeneous cell, dealing directly with fish and wildlife populations as inputs to the management system (Table 21). Generally, appropriate indicators are moderately available. Particular species of interest must be selected for this cell (and 3B) since it is not feasible to monitor all species in a state.

Table 19. Fisheries and wildlife indicators master list, cell 3A: Outputs-People.

Resource Charact.	Indicator	Approp.	Avail.	Recommended
3A-1.a	Percent of state population participating in fisheries and wildlife-related opportunities.	H	M	X
3A-1.b	Number of privately-owned fish and wildlife recreation enterprises in state.	H	M	X
3A-1.c	Rank of direct fisheries and wildlife recreation among all recreation pursuits in state, in terms of participation.	H	L	X
3A-1.d	Percent of all state recreation user-days attributable to fish and wildlife.	H	L	
3A-1.e	Number of recreationists of all types using state wildlife management areas.	H	L	
3A-2.a	Percent of population participating in consumptive resource uses, determined by harvest license sales.	H	H	X
3A-2.b	Number of consumptive users as measured by license sales.	H	H	X
3A-2.c	Number of boats participating in commercial fishery.	H	H	X
3A-2.d	Number of days spent charter boat fishing.	H	M	
3A-2.e	Percent of population participating in consumptive resource use, determined by survey.	H	M	
3A-2.f	Number of consumptive users, determined by survey.	H	M	
3A-2.g	Number of recreation days provided by consumptive use of the resource.	H	L	
3A-2.h	Number of days spent afield per animal harvested.	H	L	
3A-2.i	Percent of total recreation days in state provided by consumptive use.	H	L	

Table 19. Fisheries and wildlife indicators master list, cell 3A (continued).

Resource Character.	Indicator	Approp.	Avail.	Recommended
3A-3.a	Number of unsolicited public requests received for agency information and education materials.	H	H	X
3A-3.b	Number of subscribers to agency magazine.	H	H	X
3A-3.c	Number of people attending agency presentations.	H	H	X
3A-3.d	Number of people trained or certified by agency.	H	H	X
3A-3.e	Number of schools offering formal wildlife education curricula.	H	M	
3A-3.f	Number of accidents reported in recreation pursuits for which there exists a safety education program.	H	M	
3A-3.g	Percent of hunter training course participants who subsequently purchase a license.	H	M	
3A-3.h	Recreation-related fatality rate as percent of national average.	H	M	
3A-3.i	Percent change in ecological knowledge after a wildlife-related experience.	H	L	
3A-3.j	Percent of news releases distributed which were actually used by the media.	H	L	
3A-4.a	Percent of total fisheries and wildlife-related recreation spent in each activity type.	H	M	X
3A-4.b	Percent of recreation days spent in each type of area.	H	L	X
3A-4.c	Percent of privately-owned outdoor recreation enterprises which are oriented toward fisheries and wildlife recreation.	H	L	
3A-5.a	Consumptive recreation participation measured as a percent of recreationists who hunt only, fish only, or hunt and fish.	H	M	X

Table 19. Fisheries and wildlife indicators master list, cell 3A (continued).

Resource Charact.	Indicator	Approp.	Avail.	Recommended
3A-5.b	Percent of all consumptive effort (user-days) devoted to a particular species or group of species.	H	M	X
3A-5.c	Percent of harvest taken with each gear type.	H	L	
3A-6.a	Number of visitors to wildlife refuges or reserve areas where consumptive use is not allowed.	H	M	X
3A-6.b	Number of visitors to fish hatcheries.	H	M	X
3A-6.c	Number of nonconsumptive users in state, measured by survey.	H	M	X
3A-6.d	Percent of population participating in nonconsumptive activities, determined by survey.	H	M	X
3A-6.e	Total number of recreation days spent in nonconsumptive activities.	H	L	
3A-6.f	Number of people who purchased equipment used in nonconsumptive wildlife activities.	H	L	
3A-6.g	Number of people donating to nongame program.	M	H	
3A-6.h	Percent of population donating to nongame program.	M	H	
3A-6.i	Number of visitors to zoos.	M	H	

Table 20. Fisheries and wildlife indicators master list, cell 4A: Impacts-People.

Resource Charact.	Indicator	Approp.	Avail.	Recommended
4A-1.a	Expenditures of recreationists in pursuit of fisheries and wildlife-related opportunities.	H	M	X
4A-1.b	Amount of money contributed to economy by recreationists for each dollar spent by agency.	H	M	X
4A-1.c	Value of commercial fisheries and wildlife products.	H	M	X
4A-1.d	Amount of money contributed to economy by recreationists per animal harvested.	H	M	
4A-1.e	National rank in total value of the commercial dockside catch.	H	M	
4A-1.f	Percent of jobs in state directly related to fisheries and wildlife-based recreation.	H	L	
4A-2.a	Number of congressional inquiries regarding agency activities.	H	H	X
4A-2.b	Ratio of positive to negative unsolicited public comments received by an agency regarding management activities.	H	M	X
4A-2.c	Ratio of positive to negative press for an agency.	H	M	X
4A-2.d	Number of public comments received regarding agency actions affecting wildlife.	H	M	
4A-2.e	Amount of money donated to agency per dollar spent on publicity.	H	M	
4A-2.f	Percent of eligible taxpayers donating to agency through tax checkoff program.	H	M	
4A-2.g	Number of corporations donating advertising space to agency.	M	H	
4A-2.h	Number of local proclamations of national hunting and fishing.	M	M	
4A-3.a	Number of clubs and organizations receiving an agency newsletter.	H	H	X
4A-3.b	Number of current memberships in local, state, or national nature clubs, recreation groups, conservation organizations, or animal welfare societies.	H	M	X

Table 20. Fisheries and wildlife indicators master list, cell 4A (continued).

Resource Charact.	Indicator	Approp.	Avail.	Recommended
4A-4.a	Percent of resource users experiencing each type of personal benefit.	H	L	X
4A-4.b	Percent of resource users returning to same site of previous use.	M	L	X
4A-5.a	Percent of resource users experiencing each type of societal benefit.	H	L	X
4A-5.b	Number of resource-related outings arranged in state for special social groups.	M	M	X
4A-5.c	Percent of people satisfied with their fisheries and wildlife resource use and/or knowledge.	M	L	X
4A-5.d	Rate of violation of agency regulations.	M	L	
4A-5.e	Number of illegally killed animals.	M	L	
4A-6.a	Number of hunting accidents reported per season.	H	H	X
4A-6.b	Number of editorials or articles in newspapers addressing user conflicts.	H	M	X

Several suggestions have been offered to guide the selection of species to include in an indicator system. For any habitat type, several species should be selected (Graul et al. 1976). A single species may have specialized requirements which are not representative of most species present in an area. The variety of species chosen for monitoring may be based on the current and anticipated status of each species in the state (e.g., threatened, declining), present or potential management problems (e.g., crop damage, poaching), popularity of species among the resource-using public (e.g., harvest, observing), and the ecological roles of species within their respective communities (e.g., top predator, important forage) (Graul et al. 1976, Salwasser 1983, Verner 1983, Urich and Cannon 1985). Indicators in this cell may be related to indicators in cell 3C. For example, groups of species related to sensitive habitats (e.g., cavity nesting birds) may be monitored in this cell (and cell 3B), and old-growth habitats may be monitored in cell 3C (Salwasser 1983). Thirteen indicators were identified for this cell, nine of which are included in the recommended indicator system. Only 2 of the recommended indicators are highly available. Once the indicator system is in use, availability of these indicators will increase. Information collected for cell 3B will be applicable to these indicators. Research on populations (2B-1) will provide additional information.

Matrix cell 2B, Processes-Populations, contains highly available, highly appropriate indicators (Table 22). This section addresses actual activities performed by agency personnel. Reporting management activities does not require the extra research to assess the outcomes of man-

Table 21. Fisheries and wildlife indicators master list, cell 1B: Inputs-Populations.

Resource Charact.	Indicator	Approp.	Avail.	Recommended
1B-1.a	Number of species occurring in state, by type.	H	M	X
1B-1.b	Percent of species in state with increasing, decreasing, or stable numbers.	H	M	X
1B-1.c	Number of animals in post-harvest populations for each harvested species.	H	L	
1B-1.d	Percent of species in state with at least minimum viable population sizes.	M	L	
1B-2.a	Number of species for which status surveys have been conducted in the last 5 years.	H	H	X
1B-2.b	Percent of species within a state for which life history requirements are known.	H	M	X
1B-2.c	Percent of species within a state for which habitat suitability curves exist.	H	M	X
1B-3.a	Number of counties with reported occurrence of each species of interest.	H	M	X
1B-3.b	Percent of former range occupied by a species.	H	M	X
1B-3.c	Number of watersheds with reported occurrence of each species of interest.	H	M	
1B-3.d	Animal densities (numbers/acre) (/ha) for species of interest in each region of state.	H	L	
1B-4.a	Number of species under agency management in each taxonomic or management group.	H	H	X
1B-4.b	Percent of species in state which are in each management category.	H	M	X

agement processes that is necessary for measuring outputs and impacts. Information on activities is readily available. In the future it may be possible to relate indicators in this cell to the outputs and impacts in 3B and 4B as more active monitoring is conducted on all aspects of the resource and its management. Twenty-two indicators from this cell are included in the recommended indicator system. All are highly available and highly appropriate. This cell also contains six resource characteristics. These two factors account for this cell containing the second highest number of recommended indicators.

Matrix cell 3B, Outputs-Populations, contains two homogeneous groups of indicators (Table 23). The first group relates to outputs in terms of harvest. The second group addresses general characteristics of animal populations. Harvest indicators identified are highly appropriate and generally available. They were also cited in relatively many sources, demonstrating the high level of interest in this information as well as its current availability. Indicators of population characteristics are more variable in terms of information availability. Species to be monitored with these indicators may be selected on the basis of status, management problems, popularity with resource users, and ecological role as discussed for cell 1B. Fifteen indicators from this cell are included in the recommended indicator system, eight of which are highly available and highly appropriate. Six of the eight address concerns about harvest of fisheries and wildlife resources. Recommended indicators addressing general population characteristics are moderate to low in availability.

Table 22. Fisheries and wildlife indicators master list, cell 2B: Processes-Populations.

Resource Charact.	Indicator	Approp.	Avail.	Recommended
2B-1.a	Amount of money committed to research addressing animal populations.	H	H	X
2B-1.b	Percent of personnel time spent on population research.	H	H	X
2B-1.c	Number of research studies addressing animal populations.	M	H	
2B-1.d	Number of personnel assigned to research on animal populations.	M	H	
2B-2.a	Number of projects undertaken to manipulate wildlife population densities.	H	H	X
2B-2.b	Number of animals trapped and relocated.	H	H	X
2B-2.c	Number of days of supplemental feeding programs for wildlife populations.	H	H	X
2B-2.d	Percent of personnel time spent on population manipulation activities.	H	H	X
2B-2.e	Number of population inventories completed and/or ongoing.	M	H	
2B-3.a	Number of individuals stocked.	H	H	X
2B-3.b	Weight of animals stocked.	H	H	X
2B-3.c	Number of areas stocked.	H	H	X
2B-3.d	Number of animals distributed in cooperative raise-and-release programs.	H	H	X
2B-3.e	Percent of personnel time devoted to hatchery operation and stocking activities.	H	H	X
2B-3.f	Number of animals stocked by sources other than the management agency.	H	M	
2B-3.g	Number of hatchery or rearing facilities operated.	M	H	
2B-3.h	Number of hatchery inspections performed.	M	H	

Table 22. Fisheries and wildlife indicators master list, cell 2B (continued).

Resource Charact.	Indicator	Approp.	Avail.	Recommended
2B-4.a	Number of damage complaints investigated.	H	H	X
2B-4.b	Number of animals transplanted or killed due to damage complaints.	H	H	X
2B-4.c	Amount of money distributed for wildlife damage claims.	H	H	X
2B-4.d	Percent of personnel time devoted to animal damage prevention, investigation, and control.	H	H	X
2B-4.e	Percent of depredation complaints answered by public cooperators in agency damage control program.	H	M	
2B-5.a	Number of requests for introduced species permits investigated.	H	H	X
2B-5.b	Percent of personnel time spent in animal introduction work.	H	H	X
2B-5.c	Number of permits issued for introducing species.	H	H	X
2B-6.a	Number of rehabilitation permits issued.	H	H	X
2B-6.b	Number of agency interactions with wildlife rehabilitation centers.	H	H	X
2B-6.c	Number of animals treated in rehabilitation centers or programs.	H	H	X
2B-6.d	Percent of rehabilitated wildlife in each type of outcome.	H	H	X

Table 23. Fisheries and wildlife indicators master list, cell 3B: Outputs-Populations.

Resource Character.	Indicator	Approp.	Avail.	Recommended
3B-1.a	Number of animals in reported harvest.	H	H	X
3B-1.b	Number of animals harvested per user.	H	H	X
3B-1.c	Number of pelts registered for commercial sale by furbearer harvesters.	H	H	X
3B-1.d	Number of pounds commercially harvested, by type.	H	H	X
3B-1.e	Number of individuals commercially harvested, by type.	H	M	
3B-1.f	National rank in total weight of commercial fish harvests.	H	M	
3B-1.g	Actual harvest as percent of available or allowable harvest.	H	M	
3B-1.h	Percent of total national waterfowl flyway harvest taken in state.	H	M	
3B-1.i	Number of fish caught on charter boats during marine recreational fishing activities.	H	M	
3B-1.j	Number of fish harvested in fishing tournaments.	H	M	
3B-1.k	Number of pounds (kg) harvested recreationally, by species.	H	L	
3B-2.a	Percent of total harvest (number of individuals) contributed by each species or program.	H	H	X
3B-2.b	Number of new record fish and wildlife reported harvested.	H	H	X
3B-2.c	Number of trophy animals harvested.	H	M	
3B-2.d	Number of stocked animals which were harvested.	H	L	
3B-2.e	Percent of animals stocked which are harvested.	H	L	
3B-2.f	Ratio of female to male adults in harvest, by species.	M	L	

Table 23. Fisheries and wildlife indicators master list, cell 3B (continued).

Resource Charact.	Indicator	Approp.	Avail.	Recommended
3B-3.a	Percent of managed species in state that exhibit an increasing, a decreasing, or a stable trend.	H	M	X
3B-3.b	Percent of population change determined by direct counts for each species of interest.	H	L	X
3B-3.c	Percent of population change determined by harvest or catch per unit effort estimates for each species of interest.	H	L	X
3B-3.d	Percent of population change determined by population indices for each species of interest.	H	L	X
3B-3.e	Average standing crop of selected species or taxonomic groups.	H	L	
3B-3.f	Number of animals killed on highways, by species.	M	L	
3B-4.a	Number of species management plans updated.	H	H	X
3B-4.b	Number of studies which resulted in implemented management recommendations.	H	M	X
3B-4.c	Percent of managed species with sufficient information known about their requirements and population characteristics to set management objectives and regulations.	H	M	X
3B-5.a	Number of species for which management plans exist.	H	H	X
3B-5.b	Relative ranks of all managed species in terms of use by the public.	H	L	X

Matrix cell 4B, Impacts-Populations, addresses impacts to or caused by fisheries and wildlife populations (Table 24). Appropriate indicators were identified, but information is generally unavailable for these indicators. As discussed for cell 4A, impacts, the byproducts of management activities, are difficult to measure. For example, increases in damage reports or increases in resource utilization may be indicative of increased animal populations or increased knowledge on the part of resource users, both products of management activities. Twelve indicators from this cell are included in the recommended indicator system.

Matrix cell 1C, Inputs-Habitat, is comprised of two homogeneous groups of indicators (Table 25). Land and water holdings are in the first group, air and water quality in the second. Many of the sources in which holdings indicators were identified are state agency documents. Very few of the sources in which air and water quality indicators were identified are state publications. Traditionally, these have not been concerns of state wildlife management agencies. The breadth of this indicator system may cause some overlap in the information gathering activities of various state agencies (e.g., fisheries and wildlife-environmental protection). Such overlap may stimulate interactions and coordination among agencies to design one shared system to collect these data. All indicators identified in this cell are appropriate, but availability of information varies. Eight indicators from this cell are included in the recommended indicator system. They are evenly distributed with four pertaining to land and water holdings, and four to air and water quality.

Table 24. Fisheries and wildlife indicators master list, cell 4B: Impacts-Populations.

Resource Charact.	Indicator	Approp.	Avail.	Recommended
4B-1.a	Number of wildlife damage complaints received.	H	H	X
4B-1.b	Financial value of damage by wildlife.	H	L	X
4B-2.a	Number of species designated as endangered, threatened, or of special concern.	H	H	X
4B-2.b	Number of recovery increments achieved.	H	L	X
4B-2.c	Percent of listed species in state with completed recovery plans.	H	H	X
4B-2.d	Number of areas in state with re-established populations.	M	M	
4B-3.a	Number of harvest permits authorized, where permits are limited.	H	H	X
4B-3.b	Catch per unit effort (CPUE) for selected species compared to national average.	H	L	
4B-3.c	Ratio of actual harvest to estimated maximum sustained yield for selected species.	H	L	X
4B-3.d	Exploitation status of harvested species measured as the catch per unit effort ratio: CPUE (current)/CPUE (5 yr. average).	M	L	
4B-3.e	Percent of successful harvesters for selected species.	M	L	
4B-4.a	Percent of unmanaged species in state exhibiting an increasing trend, a decreasing trend, or a stable trend.	H	L	X
4B-4.b	Number of native species displaced or enhanced due to management for game species.	H	L	X
4B-5.a	Number of incidents reported between birds and aircraft.	H	H	X
4B-5.b	Number of human maulings or deaths by wildlife reported.	H	H	X
4B-5.c	Number of reported incidents of wildlife-related communicable diseases.	H	H	X

Table 25. Fisheries and wildlife indicators master list, cell 1C: Inputs-Habitat.

Resource Charact.	Indicator	Approp.	Avail.	Recommended
1C-1.a	Number of acres (ha) of lands under agency management.	H	H	X
1C-1.b	Number of acres (ha) of potential wildlife habitat in each ownership type.	H	M	X
1C-1.c	Ratio of public to private habitat ownership (acres or ha).	H	M	
1C-2.a	Number of surface acres (ha) and/or stream miles (km) under agency management.	H	H	X
1C-2.b	Number of surface acres (ha) and/or stream miles (km) in each ownership type.	H	M	X
1C-2.c	Number of units in each habitat type, by type of ownership.	H	M	
1C-3.a	Number of water pollution episode days reported per year.	H	H	X
1C-3.b	Percent of water bodies in state meeting water quality standards.	H	M	X
1C-3.c	Annual median concentrations of selected pollutants in a sample of state waters.	H	M	
1C-3.d	Percent of state waters receiving excess sediment.	H	L	
1C-3.e	Percent of waters with water quality problems caused by each source type.	H	L	
1C-3.f	Percent of water with water quality adversely affecting the fish community.	H	L	
1C-3.g	Percent of water bodies with no fish life.	H	L	
1C-3.h	Average annual soil erosion rate (tons/acre or kg/ha).	M	L	

Table 25. Fisheries and wildlife indicators master list, cell 1C (continued).

Resource Charact.	Indicator	Approp.	Avail.	Recommended
1C-4.a	Number of air pollution episode days reported per year.	H	H	X
1C-4.b	Percent of monitors in state receiving rain of less than 5.6 pH.	H	H	X
1C-4.c	Number of counties in nonattainment with federal air quality standards.	H	M	
1C-4.d	Annual mean concentrations of selected air pollutants, by type of area.	H	M	
1C-4.e	Percent of year selected areas were within each U.S. EPA "Pollution Standards Index" category.	H	M	

Matrix cell 2C, Processes-Habitat, is similar to the other process cells. It contains highly appropriate, highly available indicators of agency activities related to habitat (Table 26). In time, many of these indicators may be related to others in cells 3C and 4C as information on outputs and impacts becomes more available. Sixteen indicators from this cell are included in the recommended indicator system. All are highly available and highly appropriate. Habitat research contains only two indicators. The remaining 14 are relatively evenly distributed among the other four resource characteristics.

Matrix cell 3C, Outputs-Habitat, is a relatively homogeneous cell (Table 27). Highly appropriate indicators were identified, but availability varies. Of all resource characteristics in this cell, availability of information is lowest for habitat quality. Research on assessing habitat quality with simple, standard techniques is necessary. Indicators for habitat quantity were identified in the greatest number of sources (including state documents), demonstrating the interest in and availability of this information. Eighteen indicators from this cell are included in the recommended indicator system. Half are highly available and highly appropriate.

Matrix cell 4C, Impacts-Habitat, is heterogeneous in the distribution of indicators within the cell (Table 28). Many indicators were identified for preservation and environmental impacts characteristics, but few were identified for ecosystem values and scientific studies. Research is necessary to develop an information base for these latter resource characteristics, especially research addressing problems of measuring

Table 26. Fisheries and wildlife indicators master list, cell 2C: Processes-Habitat.

Resource Character.	Indicator	Approp.	Avail.	Recommended
2C-1.a	Number of sites investigated for potential acquisition.	H	H	X
2C-1.b	Number of acres (ha) approved for agency lease and/or purchase.	H	H	X
2C-1.c	Number of acres (ha) acquired and/or leased for fisheries and wildlife resource use.	H	H	X
2C-2.a	Amount of money committed to research addressing habitat.	H	H	X
2C-2.b	Percent of personnel time spent on habitat research.	H	H	X
2C-2.c	Number of research studies addressing fish and wildlife habitat.	M	H	
2C-2.d	Number of personnel assigned to habitat research projects.	M	H	
2C-3.a	Number of habitat improvement structures provided.	H	H	X
2C-3.b	Number of acres (ha) of habitat treated with improvement practices.	H	H	X
2C-3.c	Percent of personnel time devoted to habitat management activities.	H	H	X
2C-3.d	Cost of habitat improvement activities.	H	M	
2C-4.a	Number of proposed land and water development permits reviewed.	H	H	X
2C-4.b	Number of acres (ha) of habitat proposed for conversion in land and water development permits.	H	H	X
2C-4.c	Number of acres (ha) of habitat approved for conversion in permit review process.	H	H	X
2C-4.d	Percent of personnel time devoted to permit review activities.	H	H	X
2C-4.e	Number of acres (ha) habitat converted each year.	H	L	
2C-5.a	Number of pollution-related investigations conducted.	H	H	X

Table 26. Fisheries and wildlife indicators master list, cell 2C (continued).

Resource Charact.	Indicator	Approp.	Avail.	Recommended
2C-5.b	Number of fishing bans and/or health alerts issued.	H	H	X
2C-5.c	Number of fishing areas closed to commercial operators.	H	H	X
2C-5.d	Number of shoreline miles (km) or fishing acres (ha) declared closed to fishing during year.	H	H	X
2C-5.e	Percent of shellfish areas which were closed to commercial harvest at any time during year.	H	M	
2C-5.f	Percent of watersheds which were under a fish advisory or ban during year.	H	M	
2C-5.g	Number of beach closings in state due to pollution.	M	H	

Table 27. Fisheries and wildlife indicators master list, cell 3C: Outputs-Habitat.

Resource Charact.	Indicator	Approp.	Avail.	Recommended
3C-1.a	Number of acres (ha) certified in backyard habitat certification program.	H	H	X
3C-1.b	Number of acres (ha) in state in each land use/land cover type.	H	M	X
3C-1.c	Percent of state in each land use/land cover type.	H	M	X
3C-1.d	Number of acres (ha) in each ownership type specifically managed for wildlife.	H	L	
3C-1.e	Percent of land in each ownership type specifically managed for wildlife.	H	L	X
3C-1.f	Percent of land classified by vegetation structure and productivity.	H	L	
3C-2.a	Number of habitat management plans updated.	H	H	X
3C-2.b	Number of studies which resulted in implemented management recommendations.	H	M	X
3C-2.c	Percent of species in state for which habitat suitability index has been developed.	H	L	
3C-2.d	Percent of state in which habitat type has been mapped.	H	L	X
3C-3.a	Number of habitat types occurring in state.	H	H	X
3C-3.b	Number of state-owned wildlife areas managed specifically for each type of wildlife.	H	H	X
3C-3.c	Percent of recreationist use received by each habitat type.	M	L	

Table 27. Fisheries and wildlife indicators master list, cell 3C (continued).

Resource Charact.	Indicator	Approp.	Avail.	Recommended
3C-4.a	Number of land reserves or protected areas in state.	H	H	X
3C-4.b	Number of natural areas or reserves designated by the state.	H	H	X
3C-4.c	Number of acres (ha) designated as natural areas or reserves.	H	H	X
3C-4.d	Percent of total area in state devoted to reserves.	H	H	X
3C-4.e	Ratio of areas within legal reserve boundaries to areas within biotic reserve boundaries for reserves in state.	H	L	
3C-5.a	Mean size of reserves.	H	H	X
3C-5.b	Number of habitat or ecosystem types represented in reserves.	H	M	X
3C-5.c	Percent of species in state represented in reserves.	H	L	X
3C-6.a	Degree of interspersion of land use/cover types.	H	L	X
3C-6.b	For a given species or species group, percent of habitat in state suitable to support the species.	H	L	X
3C-6.c	Percent of farm acreage (ha) in state on which habitat conservation measures are practiced.	H	L	
3C-6.d	Percent of stream reaches in state experiencing less than minimum instream flows at any time of the year.	H	L	
3C-6.e	Number of miles (km) of road per square mile (km ²) of wildlife habitat.	H	L	

ecosystem values with standard techniques. Fourteen indicators from this cell are included in the recommended indicator system, but are distributed unevenly. Preservation and environmental impacts each contain five recommended indicators, whereas ecosystem values and scientific studies each contain two recommended indicators.

Matrix cell 1D, Inputs-Administration, is relatively heterogeneous in the variety of topics addressed, including revenues, personnel, and legislation (Table 29). Information for indicators in this cell is generally quite available, except for information on legislation. This is the only area in this cell which is not under control of the agency. Fifteen indicators from this cell are included in the recommended indicator system, 13 of which are highly available and highly appropriate.

Matrix cell 2D, Processes-Administration, contains highly appropriate, highly available indicators (Table 30). This cell is relatively heterogeneous, being comprised of personnel, expenditures, and agency relations characteristics. Sixteen indicators from this cell are included in the recommended indicator system. All are highly appropriate and highly available. Recommended indicators are distributed relatively evenly among the six resource characteristics.

Matrix cell 3D, Outputs-Administration, is a heterogeneous collection of indicators (Table 31). Personnel safety contains the greatest number of highly appropriate and highly available indicators. Personnel productivity is also represented well, but lacks indicators that relate the amount of work performed to specific outputs produced. As information

Table 28. Fisheries and wildlife indicators master list, cell 4C: Impacts-Habitat.

Resource Charact.	Indicator	Approp.	Avail.	Recommended
4C-1.a	Number of acres (ha) for which agency recommends proposed land and water development permits be denied.	H	H	X
4C-1.b	Number of acres (ha) acquired for mitigation purposes.	H	H	X
4C-1.c	Number of critical areas designated for threatened and endangered species.	H	H	X
4C-1.d	Percent of state land contained in state and national parks and wildlife preserves.	H	H	X
4C-1.e	Number of threatened or endangered species found on preserves.	H	M	
4C-1.f	Percent of state land in protected areas compared to national average.	H	M	
4C-1.g	Percent of development permits reviewed for which agency recommendations on habitat concerns were incorporated.	H	L	X
4C-2.a	Species diversity in selected communities or areas.	H	L	X
4C-2.b	Percent of habitat or ecosystem types represented in reserves.	H	L	X
4C-3.a	Number of reserve areas designated as research natural areas.	H	H	X
4C-3.b	Number of people cooperating on state research projects who are working for advanced degrees at state educational institutions.	M	H	X
4C-4.a	Percent of state waters for which fish kills were reported.	H	H	X
4C-4.b	Number of fish-kill incidents reported.	H	H	X
4C-4.c	Number of acres (ha) or river miles (km) reported affected in fish-kill pollution events.	H	H	X
4C-4.d	Number of fish killed in reported pollution events.	H	M	

Table 28. Fisheries and wildlife indicators master list, cell 4C (continued).

Resource Charact.	Indicator	Approp.	Avail.	Recommended
4C-4.e	Monetary value of fish killed in pollution events.	H	M	
4C-4.f	Average concentrations of toxic residues in animals, by type of residue and species or taxonomic group.	H	L	X
4C-4.g	Number of acres (ha) or miles (km) of habitat experiencing pollution, by type of pollution and habitat.	H	L	X
4C-4.h	Percent of acres (ha) lost as fisheries and wildlife habitat attributable to each development type.	H	L	
4C-4.i	Percent change in number of species present with change in recreation use.	H	L	

Table 29. Fisheries and wildlife indicators master list, cell 1D: Inputs-Administration.

Resource Charact.	Indicator	Approp.	Avail.	Recommended
1D-1.a	Total annual agency revenues.	H	H	X
1D-1.b	Revenues received from user fees.	H	H	X
1D-1.c	Revenue received from tax checkoff donations.	H	H	X
1D-1.d	Revenues received from federal aid sources.	H	H	X
1D-1.e	Percent of agency revenues derived from each source.	H	H	X
1D-1.f	Revenues available through federal aid but which reverted to the U.S. Fish and Wildlife Service.	H	H	X
1D-1.g	Ratio of change in license fees to change in consumer price index.	H	M	
1D-1.h	Net revenues from consumptive use programs (license revenues - costs of management).	M	L	
1D-2.a	Number of pieces of legislation passed during year affecting agency activities.	H	H	X
1D-2.b	Percent of legislative session devoted to addressing agency activities.	H	L	X
1D-3.a	Number of agency-owned facilities per unit land area.	H	H	X
1D-3.b	Number of agency-owned facilities per capita.	H	H	X
1D-3.c	Number of facilities in each ownership type.	H	M	

Table 29. Fisheries and wildlife indicators master list, cell 1D (continued).

Resource Character.	Indicator	Approp.	Avail.	Recommended
1D-4.a	Number of employees in agency, by type.	H	H	X
1D-4.b	Number of employees in each job category per 100,000 user-days of resource recreation.	H	L	X
1D-5.a	Number of employees with B.S., M.S., and Ph.D. degrees (or equivalent).	H	H	X
1D-5.b	Percent of employees with B.S., M.S., and Ph.D. degrees (or equivalent).	H	H	X
1D-5.c	Average number of years of experience, by job category for all personnel.	H	H	X

Table 30. Fisheries and wildlife indicators master list, cell 2D: Processes-Administration.

Resource Character.	Indicator	Approp.	Avail.	Recommended
2D-1.a	Number of requests received for agency technical assistance.	H	H	X
2D-1.b	Percent of requests for technical assistance received that were met.	H	H	X
2D-1.c	Number of cooperative agreements arranged.	H	H	X
2D-1.d	Number of assignments on professional and governmental committees held by agency personnel.	H	M	
2D-1.e	Number of other states with which an agency regularly exchanges research results and harvest information.	M	M	
2D-2.a	Number of strategic plans completed.	H	H	X
2D-2.b	Percent of personnel time spent on planning activities.	H	H	X
2D-3.a	Number of training programs offered for agency personnel.	H	H	X
2D-3.b	Percent of employees participating in training programs.	H	H	X
2D-3.c	Number of hours of training required for new employees.	H	H	X
2D-4.a	Total annual agency expenditures.	H	H	X
2D-4.b	Percent of agency expenditures devoted to each purpose.	H	H	X

Table 30. Fisheries and wildlife indicators master list, cell 2D (continued).

Resource Charact.	Indicator	Approp.	Avail.	Recommended
2D-5.a	Number of reports prepared with data processing office assistance.	H	H	X
2D-5.b	Number of species for which computerized information system is operable.	H	H	X
2D-5.c	Number of agency data processing functions which are computerized.	H	H	X
2D-5.d	Number of communications hardware devices which are in agency use.	M	H	
2D-6.a	Number of unsolicited public requests for information on agency rules and regulations.	H	H	X
2D-6.b	Number of unsolicited public complaints regarding agency rules and regulations.	H	H	X
2D-6.c	Number of revised rules and regulations.	H	H	X
2D-6.d	Percent of regulations written which are consistent with other agency policies and agreements.	H	M	
2D-6.e	Percent of resource users complying with regulations on resource use.	H	L	
2D-6.f	Average value on law complexity scale for agency regulations, as judged by resource users.	H	L	
2D-6.g	Number of days of commission (or director's) meetings devoted to rule and regulation revision.	M	H	

on outputs becomes more available, relationships can be developed between hours worked and units of output produced. Fourteen indicators from this cell are included in the recommended indicator system. Eleven of these are highly appropriate and highly available. Recommended indicators are distributed relatively evenly among the five resource characteristics.

Matrix cell 4D, Impacts-Administration, contains the fewest indicators, but also the fewest resource characteristics of any cell in the matrix (Table 32). These indicators are generally appropriate and available, although few state sources contained indicators in this cell. Because of the low number of resource characteristics and indicators identified, it appears that impacts of administration are not viewed widely as being an important component of agency operations. Seven indicators from this cell are included in the recommended indicator system.

Recommended indicators

In a discussion of the need for a system of recreation indicators, Stankey et al. (1985) noted that rarely could only one indicator provide a comprehensive measure of a management factor. They suggested using two or more indicators to measure most factors. Their management factors correspond to my resource characteristics. Accordingly, for each resource characteristic, at least 2 indicators were identified. In Tables 17-32, I have noted those indicators which I recommend be monitored by state fisheries and wildlife agencies. I have chosen these to facilitate comparisons within and among states. If a state monitors the same indi-

Table 31. Fisheries and wildlife indicators master list, cell 3D: Outputs-Administration.

Resource Character.	Indicator	Approp.	Avail.	Recommended
3D-1.a	Number of properties leased by agency to provide recreational lands for public use.	H	H	X
3D-1.b	Number of acres (ha) of lands available for public recreation.	H	L	X
3D-1.c	Number of recreation areas by ownership type and recreation opportunity available.	H	L	X
3D-2.a	Number of manuscripts written by agency employees accepted for publication or published.	H	H	X
3D-2.b	Number of reports presented at scientific or professional meetings.	H	H	X
3D-2.c	Percent of agency publications coauthored with other researchers.	M	M	
3D-2.d	Percent of articles in a given journal attributable to work performed in state.	M	L	
3D-3.a	Percent of state management areas managed for >1 species or recreation activity.	H	H	X
3D-3.b	Number of state management areas managed for >1 species or recreation activity.	H	H	X
3D-4.a	Number of staff presented with agency service awards.	H	H	X
3D-4.b	Number of publications or professional presentations per person.	H	H	X
3D-4.c	Percent of requests for professional comment received which are met.	H	H	X
3D-4.d	Number of quality arrests (defined by agency goals) per enforcement hour.	H	M	X
3D-4.e	Ratio of number of arrests to number of violators, determined by survey.	H	L	
3D-4.f	Number of hours spent in professional service activities which update the performance level of personnel.	M	H	
3D-4.g	Average number of hours worked per day.	M	H	

Table 31. Fisheries and wildlife indicators master list, cell 3D (continued).

Resource Charact.	Indicator	Approp.	Avail.	Recommended
3D-5.a	Number of accidents, attacks, or shootings reported by agency personnel.	H	H	X
3D-5.b	Number of workers' compensation claims filed.	H	H	X
3D-5.c	Amount of money spent in meeting workers' compensation claims.	H	H	X
3D-5.d	Number of safety inspections conducted.	M	H	
3D-5.e	Number of safety courses offered to agency personnel.	M	H	

Table 32. Fisheries and wildlife indicators master list, cell 4D: Impacts-Administration.

Resource Charact.	Indicator	Approp.	Avail.	Recommended
4D-1.a	Percent per year of employees leaving agency before retirement.	H	H	X
4D-1.b	Average number of years spent within the agency per employee.	H	H	X
4D-1.c	Percent of national average biologists' salaries paid to average biologist, adjusted for cost-of-living differences.	H	H	X
4D-2.a	Number of requests received for copies of agency reports or publications.	H	H	X
4D-2.b	Number of times agency reports or publications are cited in selected literature.	H	M	X
4D-3.a	Number of legislative issues for which agency provided legislature with testimony or other information.	H	H	X
4D-3.b	Number of requests received for agency review of legislative actions.	H	H	X
4D-3.c	Number of agency projects receiving increased funding.	M	H	

cators consistently over time, management trends will become much more discernible. If many states consistently monitor the same characteristics, between-state comparisons become possible. States may choose additional indicators to monitor within each resource characteristic, depending on their own agency goals and program directions. The use of additional indicators will lead to a more comprehensive representation of all aspects of each resource characteristic. The incorporation of this indicator system into state agency operations is discussed more fully in Chapter 5.

The recommended system contains 242 indicators, averaging slightly under three per resource characteristic (Table 33). The resource category of People contains the greatest number of recommended indicators. Matrix cell 2A, Processes-People, contains the greatest number of recommended indicators of any cell, contributing to the overall emphasis on People. Cell 2A contains resource characteristics pertaining to information, education, and law enforcement. These management activities have traditionally been highly reported, so indicators in this cell are very highly available. The large number of recommended indicators in this cell results from the criterion of including all highly appropriate and highly available indicators in the recommended system.

The resource category of Administration contains the fewest recommended indicators. Within this category, indicators for inputs, processes, and outputs are relatively evenly distributed. Cell 4D, Impacts-Administration, however, contains the fewest recommended indicators of any cell. This contributes to Administration containing the

Table 33. Number of recommended indicators within each matrix cell.

Resource Components	Resource Categories				Total
	People (A)	Populations (B)	Habitat (C)	Administration (D)	
Inputs (1)	12	9	8	15	44
Processes (2)	31	22	16	16	85
Outputs (3)	18	15	18	14	65
Impacts (4)	15	12	14	7	48
Total	76	58	56	52	242

fewest recommended indicators overall. One reason that cell 4D contains so few indicators is that it contains the fewest resource characteristics. Only 3 resource characteristics were identified for that cell.

Resource components Inputs and Impacts contain the fewest recommended indicators. Cells 1B, Inputs-Populations and 1C, Inputs-Habitat, are second and third lowest of all cells in the number of recommended indicators. This contributes to the low number of recommended input indicators. The scarcity of recommended indicators in cell 4D, Impacts-Administration, contributes to the relatively low number of indicators recommended for Impacts.

The resource component Processes contains the greatest number of recommended indicators. Cells 2A, Processes-People, and 2B, Processes-Populations, contain the highest and second highest number of recommended indicators of all cells. Within each resource category, the process component contains the greatest number of highly appropriate and highly available indicators, due to the relative ease of reporting agency activities compared to reporting outcomes.

The distribution of highly appropriate, highly available indicators within the recommended system highlights areas which would benefit from further research. Not including cell 2A, 45 indicators are recommended for People. Of these 45, only 13 are highly appropriate and highly available. Cell 1A, Inputs-People, contains many recommended indicators of moderate appropriateness. Very few highly appropriate indicators exist for measuring user demand and expectations. Research is needed to develop standardized methods and terminology for measuring these resource characteristics. Cells 3A, Outputs-People, and 4A, Impacts-People, con-

tain many highly appropriate recommended indicators of moderate to low availability. Monitoring systems are necessary to collect these data regularly and increase their availability.

Within the resource category of Populations, recommended indicators of the lowest availability are within cells 1B, Inputs-Populations, and 3B, Outputs-Populations. Availability of these recommended indicators probably varies among states, and certainly varies among species, depending on the specific management emphasis of each state agency. Developing and using similar population monitoring criteria in different states may enhance communications among states regarding appropriate population management strategies and probable responses.

Recommended indicators for the resource category of Habitat are high in appropriateness, but variable in availability. Within this category, cell 2C, Processes-Habitat, contains the greatest number of highly available indicators. All other cells within this category contain recommended indicators of moderate to low availability. Monitoring systems are necessary to enable collecting these data on a regular basis.

Recommended indicators for Administration are high in appropriateness and availability for all components. As previously discussed, cell 4D contains the fewest recommended indicators, partially due to the low number of resource characteristics identified for that cell. The recommended indicators within 4D, however, are highly appropriate and highly available. This cell contains the greatest percentage of highly available, highly appropriate indicators of any Impact cell.

In general, further research directed at identifying appropriate indicators is necessary for cell 1A, Inputs-People. Except for Adminis-

tration, all input, output, and impact cells would benefit from increased monitoring capabilities which would make indicators more available. Recommended Administration and Processes indicators are generally highly appropriate and highly available.

CHAPTER 5: DISCUSSION

Using the system

The fisheries and wildlife indicator system is designed to be used primarily by state agencies and their constituents. The nature of many of the indicators makes it necessary for states to perform the actual monitoring functions to obtain data for indicators. The indicator system may be implemented in the following manner.

The recommended indicator system contains 242 indicators distributed throughout the resource framework. Ideally, a state agency will develop a system to monitor all recommended indicators on an annual basis. Given the diversity of indicators in terms of subject matter and data availability, this may require creation of a specific coordinator's position responsible for fisheries and wildlife indicators. For example, a planning division position may be focused to oversee compiling data for indicators. The person with this responsibility would coordinate the recording of data necessary for indicators (e.g., personnel activity reports) and would direct other units of an agency in collecting data (e.g., scheduling which surveys are to be conducted). Ideally, data gathering for the indicator system can be integrated throughout all levels of the agency, and directed by the coordinator.

A computerized indicator information system would assist the coordinator with these duties. Depending on the indicator, information may be collected by the coordinator on a weekly (e.g., personnel activity re-

ports), monthly (e.g., license sales), or annual (e.g., user attitude surveys) basis, and entered into the information system. This need not require additional data entry costs, only use of data in another, differently formatted processing system. Computer programs may be developed to manipulate these data for calculating indicator values and/or graphical display. Computerization would facilitate greatly data compilation necessary for the use of fisheries and wildlife indicators. If a computerized indicator information system is created, technical and organizational concerns must be addressed. Lucas (1979) summarized many of the problems which have led to the failure of other types of computerized information systems. These potential problems include technical concerns such as writing and testing programs to handle the data, and organizational behavior concerns such as establishing new job duties, changing functional relationships within the agency, or simply overcoming resistance to any kind of change. Lucas (1979) noted the necessity of involving information system users in system design and operations to establish favorable attitudes toward the computerized system.

In specific applications of the indicator system (discussed below), decisionmakers or other users of the system may not be interested in examining all 242 indicators. In this case, a user would choose indicators relevant to his or her own needs. For example, all indicators may be assigned an importance weighting of 0 to 1.0 by a user. All indicators receiving a weight greater than some pre-determined value might then be considered. Another method of selecting the indicators considered at any one time is to choose one cell of interest from the resource framework,

or a group of resource characteristics, and examine only the indicators associated with these.

Although users of the indicator system may not be concerned with all recommended indicators at any point in time, all indicators should be monitored annually. If indicators are monitored for a number of years, an explicit time-series collection of statistics about the resource will be available. An analysis of this information may reveal interactions among different indicators and/or resource characteristics (Lamson 1973). The greater the number of indicators monitored, the more likely it will be that trends and interactions can be discerned (Charbonneau and Lyons 1980). The use of indicators in identifying trends and interactions may help an agency set its management priorities. For example, Jenkins (1972) noted that as the popularity of nonconsumptive activities such as viewing and photography increase, habitat trends which enhance these activities become important. Additional acres of refuge which provide viewing opportunities may be more important to meet user objectives than additional acres of breeding habitat.

The fisheries and wildlife indicator system may be integrated into agency administrative structures and operations in a variety of ways. General uses of the indicator system include: 1) integrating it into a comprehensive planning program to aid in inventory, objective-setting, monitoring, and evaluation; 2) facilitating communications with the public and special interest groups regarding agency performance in all areas of responsibility; and 3) stimulating comparisons and cooperation among states with similar programs.

Comprehensive planning programs involve four major steps: (1) inventorying the current status of resources and their use; (2) setting objectives and developing strategies to meet those objectives; (3) prioritizing objectives; and (4) monitoring and evaluating progress toward objectives (Crowe 1983). An indicator system can be integrated into all four of these stages. The system can be used in the inventory process in two ways. First, both indicators and the resource framework can be used to review the spectrum of agency concerns that require attention and assist managers and administrators in choosing which concerns are most in need of inventory or assessment. Indicators and resource characteristics for which an agency has little current information may be appropriate first targets in an inventory process. Second, indicators may help specify the units in which an inventory should be conducted (e.g., number of access areas, location of access areas). Consistent annual monitoring of all recommended indicators would quickly identify areas of concern. Monitored indicator values may be compared with previous or desired values to highlight areas which have changed in the past year or deviate greatly from desired values. Resource characteristics represented by these indicators may be prime candidates for management objectives in the next planning step.

The indicator system may be applied to the objective-setting process in a manner similar to the inventory process. The resource framework helps identify subject areas for which objectives may be necessary. Indicators provide the quantitative terms in which objectives can be written. They identify specific measurable targets to be met, which is critical to later evaluation of progress. For example, suppose resource

characteristic 2A-3, Providing Access, is recognized as an important concern. Indicator 2A-3.e measures the "percent of population living within a specified distance of recreation opportunities". First, resource managers decide if all recreation opportunities should be included, or if particular opportunities should be specified. Fishing access areas may be of most concern to a state. A reasonable distance to travel to use these areas, based on the initial inventory process, may be specified as 50 miles. An objective may then be set "to provide fishing access areas within 50 miles of the residences of 60 percent of the population".

Indicators may also be used as targets of objectives. For example, Florida (1984) set an objective "to obtain sufficient data by 1987-1988 to set a quantifiable squirrel harvest objective". Similarly, the indicator system may be used to highlight areas where data are lacking. An objective may be set to obtain sufficient data on a specified indicator or resource characteristic to enable setting quantifiable objectives in the next planning sequence.

The breadth of the resource framework and associated indicators may prove extremely useful in objective-setting processes for agencies whose work is the target of public controversy. As Crowe (1983) noted, management focus is beginning to shift from inputs and processes to outputs and impacts, and many outputs and impacts are specified in terms of harvest and general consumptive use. However, in some areas, such as the state of Massachusetts, agencies are politically unable to state objectives in these terms because of strong anti-harvest public opinion (Kristine Corey, Planner, Massachusetts Department of Fisheries and

Wildlife, personal communication). This sentiment is likely to increase as states become more urbanized (William Conlin, Planning Specialist, U.S. Fish and Wildlife Service, personal communication). The resource framework identifies a variety of potential concerns of state agencies, not solely harvest levels. Objectives may be set addressing a spectrum of concerns, recognizing the needs and interests of all user groups.

Once objectives are set, the indicator system may be used to set priorities. All objectives can be compared with the relevant indicators to identify areas where indicator values (showing the present condition) are most different from objective values (showing the desired condition). Decisionmakers can then consider this information along with overall agency goals to decide how to allocate resources among different agency activities.

Indicators may also be applied to monitoring and evaluation. Monitoring means measuring the actual outcomes of activities. Indicators can provide the basis for measurement. For example, indicator 2A-3.e can be used to measure the percent of the population living within 50 miles of fishing access areas. The value obtained for this indicator is then compared with the objective, which, in the example, was to provide access areas within 50 miles for 60 percent of the population. Evaluation is the phase of planning in which these comparisons between actual outputs and desired outputs are made. Evaluation over several years will provide trend data to highlight management activities which have been repeated successfully from year to year and activities which are repeated from year to year with little apparent benefit. Such comparisons may identify objectives which may need to be reconsidered. Data on indicators gathered

in the monitoring and evaluation stage of planning feed into the inventory process, and the planning cycle begins again. Similarly, indicators may be used in any evaluation program whether or not it is related to an agency planning process.

The second major use of the indicator system in agency operations is to facilitate communications with the public and special-interest groups. Information about all aspects of an agency's responsibilities can be provided if a broad array of indicators is monitored. Individuals concerned because they perceive an agency is too heavily involved in one subprogram (e.g., hunting) may be appeased if all of an agency's activities are reported regularly. Providing information consistently also helps avoid crisis situations, because the public is regularly informed about agency activities and resource statistics (Way 1983). Indicators may be incorporated into an agency annual report, or other documents may be developed to disseminate this information.

Special-interest groups may be encouraged to take an active role in resource management once an indicator system is a part of regular agency operations. All parties can study the resource framework, address resource characteristics in common terminology, and explain their reasons for favoring one action over another. Agency administrators and managers will be able to show explicitly where management emphasis has been or will be and why, on the basis of agency goals and indicator values. In turn, special-interest groups may become more explicit in their demands. For example, instead of lobbying for more access areas, a group may lobby instead for access areas within 50 miles of 80 percent of the population, rather than the 60 percent set as an agency objective.

The third major use of the indicator system is in stimulating comparisons and cooperation among states with similar programs. If the core set of indicators recommended in Chapter 4 is monitored by all state agencies, comparisons become quite feasible. State fisheries and wildlife agencies may be stimulated to create an information exchange similar to the Annual Information Exchange of the National Association of State Park Directors. The Annual Information Exchange was created to provide an ongoing source of state park use data for recreation directors (Yardas et al. 1982). In this exchange, data are presented on state recreation acreages, types of recreation, facilities, visitation, capital outlays, and personnel.

A fisheries and wildlife information exchange may be coordinated by regional associations of fish and wildlife agencies, or possibly by the International Association of Fish and Wildlife Agencies. Some indicators will differ among states because of differences in species, habitat, or primary use types. It is also likely that in addition to the core indicators, or in place of some core indicators, individual states will choose other indicators that relate more specifically to their own needs. However, a sufficient number of indicators should be monitored by all states to allow comparisons to be made. States experiencing declines in desirable indicators may consult with states exhibiting increases to compare strategies of management. State comparisons may also help to avoid misinterpreting abnormal increases or declines which are due to measurement error rather than real data. States with similar resource bases and use patterns may consult with one another regarding feasible objectives and management programs. Agencies may also use this information in communi-

cations with special-interest groups as a way of portraying agency results. If an agency's relative rank in the value of an indicator has improved, this can be used as a selling point to convince special-interest groups of an agency's productivity and responsiveness to their wishes.

General implications

Use of the fisheries and wildlife indicator system can influence the field of fisheries and wildlife management in three ways. First, administrative documents (e.g., annual reports) may address a broader range of topics and become more resource- and user-oriented. Second, promising new areas of research may be identified. Third, decisionmaking processes may move from use of intuition to more explicit reasoning.

In Chapter 2, I discussed results of an analysis of state agency annual reports, and offered six recommendations for improving state reports. Each of those recommendations are addressed by using the indicator system. First, the indicator system can increase information reported on fisheries and wildlife resources, their use, and actual management activities. The resource framework identifies a broad spectrum of agency responsibilities, including resource (Populations, Habitat), user and use (People), and administrative concerns.

Second, correspondence between management objectives and information included in annual reports can increase. If indicators are used in a comprehensive planning program as discussed earlier in this chapter, management objectives will be formulated and evaluated based on the in-

indicator system. Objectives will be stated in terms of an output to be produced. Indicators will measure how well each objective has been met.

Third, use of the indicator system will allow an agency to address its performance over the past year, compare it with performance in previous years, and state in quantitative terms what is expected in the future. Consistent monitoring of indicators over time will provide a time-series data collection which is necessary for such comparisons. Future expectations may be stated as objectives based on particular indicators.

Fourth, indicators may stimulate agencies to include early information on evolving programs so that future development can be assessed. The resource framework contains resource characteristics which are beginning to be recognized as important functions of agency activities or oversight (e.g., nonconsumptive use, animal rehabilitation). With use, and as agency programs change and expand, the resource framework may be expanded to include new concerns.

Fifth, the indicator system provides measures of agency performance which allow time comparisons within a state and comparisons of progress among states. I recommended a core group of indicators to be monitored by all state agencies. In time, as data on a variety of indicators become available, this core group of indicators may allow intra- and inter-state comparisons to be made.

Sixth, presentation of indicator values may be done to attract the reader, using a variety of textual, tabular, and graphical methods. Indicators are presented very effectively in tabular or graphical form. Explanatory text, explaining indicator interactions and reasons for

trends, supplements the tables and graphs. An example of graphical indicator presentation is Fig. 7, showing values for a progression of years along with a future objective.

Use of the indicator system will help identify new areas for research. The distribution of appropriate, available indicators among resource characteristics highlights areas which would benefit from research on evaluation methods. For example, as discussed in Chapter 4, few highly appropriate and highly available indicators exist for demand (especially nonconsumptive) and for user expectations. In general, measurement of impacts and outputs can be improved through research designed to develop easily-implemented, standard evaluation techniques for areas in which monitoring is currently lacking.

Collection of time-series data through the indicator system will help generate research hypotheses on the interactions among the resource, its management, and use. The existence of time-series measurements of social indicators has stimulated research and analysis in that field to explain observed interactions (Pool 1983). Charbonneau and Lyons (1980) expressed the need for research examining causal relationships to explain trends in fisheries and wildlife statistics. The indicator system outlined herein cannot demonstrate causality. It can make apparent trends in a variety of factors and stimulate research designed to examine what appear to be related trends and to determine causal relationships. It may be feasible to test hypotheses about effects of certain management activities using time-series data (Stagner 1970). Once background data are collected for selected indicators, a change in management may be in-

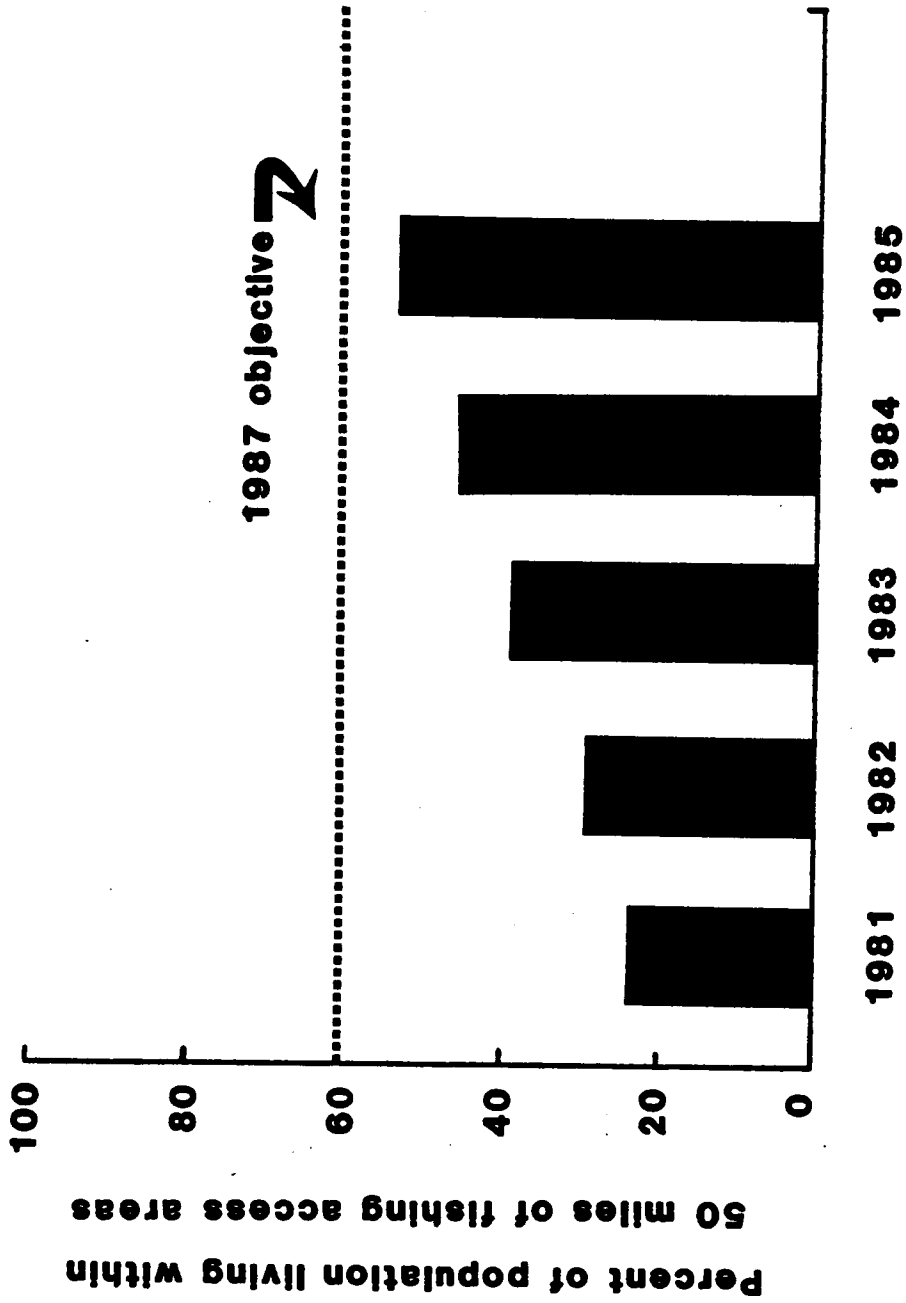


Fig. 7. Example of indicator presentation.

troduced in selected areas (e.g., districts), and subsequent change in indicators monitored.

The indicator system may also prove useful in other applications, such as environmental and social impact analysis. Kellert and Brown (1985) noted the need for standardized measures of the wildlife resource for use in assessing impacts resulting from development and preservation projects. If time-series data on indicators are available, before-and-after analyses may be performed in relation to a particular project. Results from such an analysis may then be applied to assessments of similar proposed projects.

The third area of influence from the indicator system on fisheries and wildlife management is on decisionmaking processes. As I discussed in Chapter 1, three modes of thought are relevant to decisionmakers (Hammond 1978). Mode 6 relies on intuition and an unknown data base. Mode-5 thought involves decisions based on a known set of data but on unknown weightings of the importance of the data. Mode 4 involves using cognitive aids such as descriptive statistical analyses, computer simulations of environmental circumstances, and explicit analyses of judgment and decision processes.

Use of the indicator system will signal a shift from current mode-6 decisionmaking to mode 5 because decisionmaking processes will be made more explicit. The indicator system will promote open discussions about important resource characteristics and their measures. The choice of resource characteristics from among the resource framework and the choice of specific indicators are apparent. Carey (1979) emphasized the benefits that would accrue from using an indicator system. Common terminology (the

resource framework) and explicit measures of the state of natural resource management (specific indicators) are critical to effective public involvement programs. Decisionmakers may be questioned directly as to why one resource characteristic or one indicator was chosen above another as being more important. The use of intuition and hidden, implicit decision criteria will decline.

Susceptibility of agency staff to political pressures will likely decline if an indicator system is used. Changes in indicator values serve as specific criteria for changing or instituting new management actions, as in the evaluation phase of a comprehensive planning program. When political pressures are placed on an agency to derail a particular program, the burden will be on those creating the pressure to justify why an accepted, explicit decision system should no longer be followed (Fraser 1985).

Using mode-4 thought processes is currently hampered by the complex nature of the fisheries and wildlife resource and the lack of complete monitoring capabilities. Consistent use of the indicator system will address both of these problems. Interactions among many of the fisheries and wildlife resource characteristics may be analyzed once time-series data are available. Monitoring capabilities will be developed as an integral part of indicator system use.

Mode-4 decisionmaking is characterized by using decision-aids such as weighting systems and simulation modeling. Using the indicator system and associated research into cause and effect relationships and interactions may lead to the development of algorithms required for these decisionmaking aids. Care must be taken, however, to involve the users

of these decision aids in developing them. If users develop their own algorithms for decision aids based on specific intended applications, it is more likely that those decision aids will be incorporated into agency planning and administrative operations (Bisselle et al. 1971). Hirst (1984) warned against the "academic preoccupation with numerical indices and their sophisticated manipulation". Agency decisionmakers have difficulty relating to aggregate index values which represent a composite set of data, and incorporating index values into agency actions and programs (Hirst 1984). If decisionmakers guide the development of decision aids to meet their own needs, these problems may be alleviated.

Implementation concerns

Practically, the use of any type of monitoring system must be based on the availability of resources such as time, personnel, and money, and the interest or willingness to implement the system. Many of the indicators recommended for monitoring by all state agencies were those judged highly available and highly appropriate. These indicators should be faced with the fewest barriers to their implementation.

The size of the recommended indicator system, with 242 indicators, may prove to be unmanageable if agencies attempt to monitor all indicators continuously as suggested. As the system is used, correlations among indicators may become apparent. Some indicators may be dropped from the system if they are correlated with other, more easily attained, indicators. Repetitions exist in the system, the output of one year becoming the input to the next. These data should not be hard to obtain if in-

formation collection, storage, and retrieval are coordinated so that data are not lost from one year to the next.

As discussed in Chapter 4, the distribution of indicators among resource characteristics in the framework is uneven. Process characteristics are emphasized over other resource components. To achieve a more even distribution, process indicators should be examined first to discover correlations among indicators and to choose those most representative of each resource characteristic.

Users of the indicator system should proceed with caution. Indicators cannot be considered predictors of the future, but should be viewed as guides to current decisions based on past and present trends. As discussed, research on relationships among indicators and management activities may later add predictive power to the indicator system by identifying predictable changes in indicator values following particular management activities. Positive or negative changes in indicator values should not be interpreted as inherently good or bad for the resource. Changes must be interpreted in relation to stated needs of users and objectives of resource management.

The indicator system itself should be monitored through time. Definition of certain indicators may change as legal criteria (e.g., water quality standards) change. Indicators must be interpreted with these changes in mind, especially when considering trends over several years. New indicators may be developed which are more appropriate for certain resource characteristics than the current indicators. These may be added to the present system, or may replace those indicators judged less ap-

appropriate. The indicator collection will be dynamic, allowing for additions or deletions as time and research identify better indicators.

The resource framework, however, should remain relatively stable. The 16 cells of the framework provide the basis for organizing the fisheries and wildlife indicator system. Resource characteristics within each cell provide a classification system representing all current responsibilities and concerns of fisheries and wildlife management. Barring any unforeseen reorganization of the fisheries and wildlife profession, these characteristics should continue to provide the basis for identifying necessary indicators. If agencies are faced with new responsibilities, additional resource characteristics may be added to the appropriate framework cell.

The ultimate barrier to implementing and using the indicator system is the resistance that may be found within fisheries and wildlife agencies. The disaggregated nature of the resource framework and indicators makes it possible to link indicator values to specific programs or administrative units. There may be a direct relationship between anticipated indicator values and an agency's (or a specific unit's) willingness to assist in data collection. The less desirable the indicator values, or the more marginal the activities indicated, the stronger may be the resistance to cooperation. In this situation, implementing the indicator system may be facilitated by strong public sentiment in favor of a comprehensive evaluation system, by agency planners in favor of explicit methods with which to measure objectives, or by "competition" from neighboring states which are using the indicator system as a selling point for their programs.

The next step

I patterned my efforts to develop a fisheries and wildlife indicator system after similar efforts with social indicators. As discussed in Chapter 1, movements within the fisheries and wildlife profession have mirrored early developments in social indicators research. Fisheries and wildlife concerns shifted from concepts of maximizing yield to satisfying multiple objectives. Time-series data became important, but the emphasis was on using data series that were already available rather than collecting comprehensive, pre-selected information. The fisheries and wildlife indicator system addresses this deficiency, identifying a set of indicators representing all characteristics of the resource and its management. However, many of the indicators were recommended, as in past agency actions, based on the availability of data. Research is needed to identify which indicators are most appropriate for a given resource characteristic and to increase the availability of data for those indicators.

The next phase of social indicator development reflected in fisheries and wildlife management was that of using subjective measures of attitudes and perceptions. These characteristics are included in the indicator system, but are generally the weakest component of the system in terms of highly appropriate and highly available indicators. Research is needed to identify appropriate indicators of people's demands and perceptions and standard methods of measurement.

The third phase of social indicator development was that of analyzing trends using time-series data. The fisheries and wildlife indicator

system provides this capability if implemented by state agencies. Social indicator research is now in its fourth phase, moving away from simple time-series descriptions to developing explanatory models for analysing social causation and predicting social change (Carley 1981). The fisheries and wildlife indicator system may be useful in identifying similar research questions as discussed earlier in this chapter.

Verwayen (1984) described two related but distinct activities involved in indicator development. The first of these two activities is "conceptual development". According to Verwayen, this stage involves specifying abstract notions in concrete, quantifiable terms. The process is knowledge-intensive, requiring analytical and creative skills, but not necessarily a large number of people, equipment, or resources. Verwayen's description is appropriate for my work in developing the indicator system, especially creating the resource framework and identifying potential indicators. The second stage described by Verwayen is "data development". This stage is characterized by efforts to adapt existing data collection and data processing systems, or create new ones, to meet the new requirements for information identified in the first stage. This process generally involves a large number of people, equipment, and resources. This is the next step to take in application of my results.

A major contribution of my work has been to identify potential indicators and highlight areas in which additional research is needed. The indicator system I developed provides a coordinated, systematic monitoring scheme where none, to my knowledge, currently exists. Some of the indicators are limited in scope or availability, but the system provides the basis for future efforts to refine specific measures of resource

characteristics and to develop new approaches for data collection. An heuristic approach, in which the indicator system is improved through experience and research, is appropriate. In any indicator system, operational experience in measuring and using indicators is necessary before the system can be validated and refined (Pikul et al. 1972). As Thomas (1972) noted, an initial indicator system is usually based on choosing indicators to use available data. Eventually, as use of the system develops, data collection methods change to provide the most appropriate data for desired indicators.

Any changes made in indicators or measurement techniques should be made in an explicit manner so that they may be reviewed clearly by others (Stankey et al. 1985). It is a natural occurrence as indicator systems evolve that indicators will change gradually as information needs of system users become clearer and new data collection, storage, and retrieval methodologies, and analytical techniques are developed (National Science Board 1981). Economic concerns may also be entered into a consideration of indicators in the future. Actual costs of obtaining data for particular indicators may be used in setting priorities about which to monitor. The cost of using the indicator system may become an accepted cost of management agency operations. The indicator system I developed addresses costs indirectly and subjectively, through the ratings each indicator received for "availability". With use, actual costs may be determined.

This is intended to be a dynamic system. With time, data for certain indicators may become more available, and more appropriate indicators may be developed. The fisheries and wildlife indicator system has the poten-

tial for improving state agency administration, communications, and decisionmaking techniques.

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APPENDIX A. LIST OF FISHERIES AND WILDLIFE INDICATORS

Presented here are all indicators identified in the indicator search described in Chapter 4, Tables 17-32. The number associated with each indicator (e.g., 1A-1) refers to individual resource characteristics in the fisheries and wildlife framework. At least 2 indicators (selected as in Chapter 4) are described for each resource characteristic. Each description explains where data for an indicator may be available, and discusses potential variations of an indicator. Many of the potential data sources listed in this section are described in detail in Yardas et al. (1982). All indicators described in detail are recommended for state agencies to monitor. All other indicators identified for each resource characteristic are listed. The number in parentheses following each source refers to the type of source as follows: (1) agency documents which describe an indicator in use; (2) reports demonstrating the validity or biases of a particular indicator, or describing research which has been performed on a particular indicator; (3) reports in the literature which offer no supporting data, but simply suggest that a particular indicator may be useful for agencies to measure; and (4) my own suggestions for indicators for resource characteristics for which I could identify no suitable indicators in the literature. Throughout the appendix, "agency" is used to refer to that administrative unit with responsibility for fisheries and wildlife management.

1A: INPUTS-PEOPLE

1A-1: Demand: Quantity

1A-1.a. Percent of population purchasing a harvest license.

Sources: Maryland (1985) (1)

Appropriateness: Moderate

Availability: High

This measure can be used as an indicator of demand for consumptive resource use. The data should be readily available in agency records (number of licenses sold) and state population records from the appropriate office in a particular state. This indicator can be used in conjunction with information on state population trends to predict future demand, assuming a constant proportion of the population remains interested in consumptive resource use (Kaiser and Moeller 1980). This indicator is not a direct measure of demand. Any measure of demand based on actual participation assumes that people know what is available to them and that they are doing what they want to be doing (Outdoor Recreation Policy Review Group 1983).

1A-1.b. Percent of population donating to the nongame program.

Sources: Kansas (1985) (1)

Appropriateness: Moderate

Availability: High

This measure pertains to nonconsumptive use of the resource. It is most relevant to states with some mechanism established for nongame donations to be made (e.g., tax checkoff). Data should be available in agency records or tax office records, and in state population records. Predictions based on population trends can be made using this indicator as discussed for 1A-1.a. This is not a direct measure of nonconsumptive demand for reasons discussed in 1A-1.a. This indicator does not address nonconsumptive users who cannot afford to donate to the nongame program or do not know about the program, and assumes that everyone who does or wants to participate in nonconsumptive resource use would donate to the nongame program.

1A-1.c. Number of applicants for each harvest license available, where number of licenses is limited.

Sources: Wyoming (1984) (1), Kansas (1985) (1)

Appropriateness: Moderate

Availability: High

1A-1.d. Per capita purchase of harvest licenses.

Sources: Davis and Seneca (1972) (2)

Appropriateness: Moderate

Availability: High

1A-1.e. Number of harvest licenses sold.

Sources: Davis and Seneca (1972) (2), Maryland (1985) (1)

Appropriateness: Moderate

Availability: High

1A-1.f. Number of anglers and hunters determined by survey.

Sources: USDI and USDC (1982) (1)

Appropriateness: Moderate

Availability: Moderate

1A-1.g. Percent of population engaging in some form of resource use or enjoyment, determined by survey.

Sources: Tennessee (1982) (1), USDI and USDC (1982) (1), Kansas (1985) (1)

Appropriateness: Moderate

Availability: Moderate

This measure relates to all users of fisheries and wildlife resources, consumptive, nonconsumptive, and indirect. It is not a direct measure of demand for reasons discussed for 1A-1.a and 1A-1.b. A survey would be necessary to obtain these data. This indicator is recommended for state agencies to monitor because it measures all resource users, not just one interest group. Data for this indicator should be available in the 5-year survey conducted by the U.S. Fish and Wildlife Service.

1A-1.h. Number of days of hunting and fishing occurring annually.

Sources: Idaho (1978) (1), Maryland (1985) (1)

Appropriateness: Moderate

Availability: Low

1A-2: User Characteristics

1A-2.a. Percent of resource users in each age group.

Sources: Charbonneau and Lyons (1980) (2), Kaiser and Moeller (1980) (2), Graf and Schenborn (1984) (3), Kershner and Vankirk (1984) (2), Shaw and Mangun (1984) (3), Snepenger and Ditton (1985) (2)

Appropriateness: High

Availability: High (for consumptive users)

Information regarding this indicator would be available in the form of birthdate information on state license records for consumptive users of the resource. Similar information for nonconsumptive users would be difficult to obtain, probably necessitating a survey. Age is an important characteristic of users. One goal of public sector agencies such as fisheries and wildlife agencies is to serve all people. As people age, their interests, needs, and capabilities change. For example, Leenhouts (1976) showed that deer hunter values change with hunter age. As values and interests change, demands for resource use will presumably change. Attention to the age

structure of the user population will enable resource agencies to serve better their clientele.

1A-2.b. Percent of resource users in each gender.

Sources: Charbonneau and Lyons (1980) (2), Kershner and Vankirk (1984) (2), Shaw and Mangun (1984) (3), Snepenger and Ditton (1985) (2)

Appropriateness: High

Availability: High (for consumptive users)

State license records would also be an appropriate source for this indicator for consumptive users. Gender is often included on licenses as an identification characteristic. A survey would be required for nonconsumptive users. This information can be used in conjunction with the gender characteristics of the state population to identify potential users who are currently not using the resource. Agency programs can be implemented to target this untapped pool of users.

1A-2.c. Percent of resource users in each region of state (e.g., by management districts), or by type of region (e.g., metropolitan, urban, rural).

Sources: Hay and McConnell (1979) (2), Charbonneau and Lyons (1980) (2), Miller and Hay (1981) (2), Graf and Schenborn (1984) (3), Snepenger and Ditton (1985) (2), USDC (1985c) (1)

Appropriateness: High

Availability: Moderate

Use of this indicator will highlight areas in the state where more resource opportunities may be targeted successfully. This information would be available through an analysis of residences listed on harvest license permits for consumptive users, and through a survey for nonconsumptive users.

1A-2.d. Percent of resource users in each educational bracket.

Sources: Shaw and Mangun (1984) (3)

Appropriateness: High

Availability: Low

1A-2.e. Percent of resource users in each income bracket.

Sources: Hay and McConnell (1979) (2), Charbonneau and Lyons (1980) (2), Miller and Hay (1981) (2), Shaw and Mangun (1984) (3)

Appropriateness: Moderate

Availability: Low

1A-2.f. Percent of resource users in each racial group.

Sources: Shaw and Mangun (1984) (3)

Appropriateness: High

Availability: Low

1A-3: User Expectations

1A-3.a. Percent of resource users by reason for participation.

Sources: Snepenger and Ditton (1985) (3)

Appropriateness: High

Availability: Low

A survey of resource users to determine motivations for participation would be necessary. Possible motivation types include: bagging game, observing wildlife, spritual inspiration, risk taking, enjoying scenic beauty, learning about nature, being with others, finding solitude, spending time with family, escaping social pressures, meeting new people, physical exercise, developing skills, improving health, demonstrating skills, teaching youth. Management objectives can be tailored to help meet these expectations, or to change motivations and expectations to correspond better to what the resource can realistically offer.

1A-3.b. Percent of resource users in each attitude class.

Sources: Kellert (1984) (3)

Appropriateness: Moderate

Availability: Low

A survey of resource users to determine their attitude types would be necessary. Kellert's attitudes include:

naturalistic, ecologicistic, humanistic, moralistic, scientific, aesthetic, utilitarian, dominionistic, and negativistic. Attitude class is less likely than motivations to reflect actual user expectations. A range of activities is appropriate for each attitude type, whereas "bagging game" as a motivation is quite specific.

1A-4: Demand: Type of Experience

1A-4.a. Percent of population preferring a given type of experience.

Sources: Idaho (1978) (1), Shaw and Mangun (1984) (3), Harris and Bergerson (1985) (2)

Appropriateness: High

Availability: Low

A survey would need to be developed to obtain these data. Types of experience may be classified by consumptive and nonconsumptive activities. Consumptive wildlife activities may be grouped by the type of target species, e.g., big game, waterfowl, furbearers. Consumptive fisheries preferences can be classified by type of fishery, e.g., put-and-take, wild, trophy, urban. These data may be used to modify agency objectives to provide a more desired mix of resource use opportunities.

1A-4.b. Percent of population desiring resource use opportunities within a given distance of their residence.

Sources: Commonwealth of Virginia (1984) (1)

Appropriateness: High

Availability: Low

A survey would be necessary to obtain these data. A range of distances appropriate to management activities could be used, as well as use classified by management type as above. This measure may be indicative of areas needing more recreation opportunities. For example, if put-and-take fisheries are desired within 30 miles of most residences, concentrating them around urban centers may be a feasible management strategy.

1A-4.c. Number of miles actually traveled by users to each type of resource use.

Sources: Snepenger and Ditton (1985) (2)

Appropriateness: Moderate

Availability: Low

1A-4.d. Percent of resource users using public lands.

Sources: Shaw and Mangun (1984) (3)

Appropriateness: Low

Availability: Low

1A-5: Costs to Users

1A-5.a. Cost of harvest licenses, by type.

Sources: USFWS (1980) (1), Oregon (1982) (1), Virginia CGIF (1982) (1)

Appropriateness: High

Availability: High

This measure is indicative of one type of cost borne by consumptive users of the resource. Data are readily obtainable in agency records. This does not address any other costs, or nonconsumptive users. This measure can be used with economic measures of the inflation rate or cost of living to determine how relative cost of licenses changes over time.

1A-5.b. Average annual expenditure per user for recreation involving the fisheries and wildlife resource.

Sources: Snepenger and Ditton (1985) (2)

Appropriateness: High

Availability: Low

A survey of users would be necessary to obtain data for this indicator. While it is difficult to determine precisely how much of recreation expenditures are attributable to use of fisheries and wildlife resources versus how much would be spent even in the absence of resources, this measure is still useful

as an indicator. It allows a general assessment to be made of costs actually incurred by people in their uses of the resource. It may be used with other indicators (e.g., 1A-2.d) to determine how use changes as costs of use change.

1A-5.c. Average expenditure per trip for recreation involving the fisheries and wildlife resource.

Sources: Tennessee (1982) (1)

Appropriateness: High

Availability: Low

1A-5.d. Average daily expenditure for recreation trips involving the fisheries and wildlife resource.

Sources: Weithman and Haas (1982) (2), Menz and Wilton (1983) (2), Wyoming (1984) (1)

Appropriateness: High

Availability: Low

2A: PROCESSES-PEOPLE

2A-1: Education Activities

2A-1.a. Number of workshops conducted for educational instruction.

Sources: Arizona (1981) (1), Missouri (1982) (1), Oregon (1982) (1), Virginia CGIF (1982) (1), Pettus and Auldridge (1984) (3), Wyoming (1984) (1)

Appropriateness: High

Availability: High

Information and education division records should contain the data necessary for this indicator. The measure can be refined by specifying the type or purpose of the workshop (e. g. , Project Wild workshops for school teachers, Hunter Safety Instructor workshops). This indicator may be used in conjunction with others (e. g. , Section 3A or 4A) to highlight possible relationships between educational activities and people's responses.

2A-1.b. Number of requests received for speakers to make presentations at schools.

Sources: Arizona (1981) (1), Missouri (1982) (1), Oregon (1982) (1)

Appropriateness: High

Availability: High

Data should be available in information and education division records. Requests for presentations indicate that an agency's activities are viewed as important, but also that an agency is viewed as having competent educators on staff. Unsolicited requests also demonstrate that the agency has been effective in publicizing its educational services.

2A-1.c. Rating received by hunter education program.

Sources: Benson (1985) (2)

Appropriateness: High

Availability: High

Ratings are given to hunter education programs by the International Association of Fish and Wildlife Agencies. Ratings range from A (lowest) to AAA (highest). This indicator allows comparison among states, as the "grade" for each state is assigned by the same evaluating organization.

2A-1.d. Percent of personnel time spent preparing curriculum development materials for schools or outdoor education programs.

Sources: Missouri (1982) (1), Oregon (1982) (1)

Appropriateness: High

Availability: High

Personnel activity records should contain this information. This indicator may be compared with the amount of staff time

spent in other activities to assess the relative emphasis placed on each activity.

2A-2: Information to Users

2A-2.a. Number of news releases written per year.

Sources: Svoboda (1980) (3), Oregon (1982) (1), Virginia CGIF (1982) (1), Wyoming (1984) (1), Maryland (1985) (1)

Appropriateness: High

Availability: High

Data for this indicator should be available in information and education division records. News releases serve to inform the public about upcoming activities, agency policies, and recent agency actions.

2A-2.b. Number of audio-visual productions completed per year.

Sources: Svoboda (1980) (3), Arizona (1981) (1), Missouri (1982) (1), Oregon (1982) (1), Virginia CGIF (1982) (1), Wyoming (1984) (1), Maryland (1985) (1)

Appropriateness: High

Availability: High

Audio-visual records should be available from the information and education division. Productions may be classified accord-

ing to the type of medium (e. g. , radio, video, motion pictures, photography).

2A-2.c. Number of information publications prepared.

Sources: Missouri (1982) (1), Tennessee (1982) (1), Virginia CGIF (1982) (1), Wyoming (1984) (1), Maryland (1985) (1)

Appropriateness: High

Availability: High

Information and education division records should contain these data. Publications may be classified according to type (e. g. , brochures, newsletters, magazines) or purpose (e. g. , angling tips, recipes, guides for wildlife observation).

2A-2.d. Number of information programs presented to the public.

Sources: Svoboda (1980) (3), Arizona (1981) (1), Oregon (1982) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

Information and education division records should contain these data. Programs may be classified according to type (e. g. , state fair booths, slide shows).

2A-2.e. Percent of personnel time spent on information and education activities.

Sources: Arizona (1981) (1), Oregon (1982) (1), Virginia CGIF (1982) (1), Maryland (1985) (1)

Appropriateness: High

Availability: High

Personnel activity records should contain this information. This indicator may be compared with the amount of staff time spent in other activities to assess the relative emphasis placed on each activity.

2A-2.f. Percent of information inquiries to the agency which were answered.

Sources: Arizona (1981) (1), Missouri (1982) (1), Oregon (1982) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: Moderate

2A-2.g. Number of times audio-visual productions were used.

Sources: Arizona (1981) (1), Oregon (1982) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: Moderate

2A-2.h. Number of media interviews in which field personnel participated.

Sources: Svoboda (1980) (3), Missouri (1982) (1), Oregon (1982) (1)

Appropriateness: High

Availability: Moderate

2A-2.i. Number of news releases actually printed or broadcast.

Sources: B. Knuth (4)

Appropriateness: High

Availability: Low

2A-2.j. Number of recipients of new releases.

Sources: Arizona (1981) (1), Oregon (1982) (1), Wyoming (1984) (1)

Appropriateness: Moderate

Availability: High

2A-2.k. Renewal rate for agency magazine subscriptions.

Sources: Wyoming (1984) (1)

Appropriateness: Moderate

Availability: High

2A-2.l. Percent of budget spent on agency promotions.

Sources: Applegate and Trout (1984) (3)

Appropriateness: Moderate

Availability: High

2A-2.m. Volume of publication sales, in dollars.

Sources: Arizona (1981) (1), Virginia CGIF (1982) (1)

Appropriateness: Moderate

Availability: High

2A-3: Providing Access

2A-3.a. Number of new access areas acquired or constructed.

Sources: Irland and Rumpf (1980) (3), USFWS (1980) (1), Oregon (1982) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

This information should be available in agency fiscal records and land acquisition records. Access areas may be categorized by type of area (e.g., boat ramps, parking areas).

2A-3.b. Total number of access areas maintained or under lease.

Sources: Virginia CGIF (1982) (1)

Appropriateness: High

Availability: High

Data for this indicator should be available in agency maintenance division records. This measure, in conjunction with 2A-3.a, may be used to assess the availability of access sites.

2A-3.c. Percent of budget spent on access site acquisition and development.

Sources: USFWS (1980) (1)

Appropriateness: High

Availability: High

Agency fiscal records on expenditures would be a likely source for this information. The relative importance of providing access may be compared with other agency activities by examining the percent of the budget spent on this activity.

2A-3.d. Number of miles (km) of road controlled and maintained.

Sources: Virginia CGIF (1982) (1)

Appropriateness: High

Availability: High

Maintenance or engineering division records should contain this information. Accessibility of resources includes the ability to reach specific access sites like boat launches along well-maintained roads.

2A-3.e. Number of acres (ha) accessible through cooperative agency contracts with landowners.

Sources: Teer et al. (1983) (2)

Appropriateness: High

Availability: High

Data for this indicator should be available in agency records as contracts should be kept on file. Access may be characterized by type of use (e.g., hunting, fishing).

2A-3.f. Percent of population living within a specified distance of recreation opportunities (e.g., fishing lake, trout stream, wildlife management area).

Sources: Cordell and Hartmann (1982) (2)

Appropriateness: High

Availability: Moderate

Gathering this information would help to assess the need for placement of additional access areas and indicate areas where sufficient access is provided. These data should be available through an analysis of state population records compared with locations of known recreation opportunities. It may be used to assess how well user desires (1A-4.b), and then use patterns (1A-4.c), relate to the location of recreation opportunities.

2A-3.g. Percent of landowners posting property against trespass.

Sources: Brown et al. (1983) (2)

Appropriateness: High

Availability: Low

2A-4: Landowner Assistance

2A-4.a. Number of contacts with landowners to give technical assistance.

Sources: Missouri (1982) (1), Teer et al. (1983) (2)

Appropriateness: High

Availability: High

These data should be available in personnel work records and schedules. The most direct forms of assisting landowners with implementing sound management practices are personal visits and telephone contacts. This indicator measures both of these methods, or may be refined to address each separately.

2A-4.b. Number of short courses offered to landowners regarding management practices.

Sources: Missouri (1982) (1)

Appropriateness: High

Availability: High

Agency records or personnel work reports should contain this information. Short courses are a formal method of assisting landowners with land management.

2A-4.c. Number of cooperative agreements between agency and landowners for private land management.

Sources: Missouri (1982) (1), Teer et al. (1983) (2)

Appropriateness: High

Availability: High

Agency records should contain this information. This indicator may be refined by specifying the type of management agreement (e.g., farm pond stocking, woodland management).

2A-4.d. Number of management plans produced for landowner cooperators.

Sources: Missouri (1982) (1), Tennessee (1982) (1), Teer et al. (1983) (2)

Appropriateness: High

Availability: High

Agency records or work reports should contain this information. Management plans produced for a landowner are indicative of the commitment of an agency to assisting landowners. This indicator may be used with 2A-4.a and 2A-4.c to determine the number of contacts and cooperative agreements which result in management plans being produced. The number of acres involved may also be included to further refine this indicator.

2A-4.e. Percent of personnel time devoted to landowner assistance.

Sources: Missouri (1982) (1), Oregon (1982) (1), Teer et al. (1983) (2)

Appropriateness: High

Availability: High

Personnel work reports should contain data for this indicator. Relative importance of landowner assistance activities may be assessed by comparing this indicator to time spent on other activities of interest.

2A-5: Public Input Opportunities

2A-5.a. Number of formal public meetings held.

Sources: Missouri (1982) (1), Virginia-MRC (1982) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

Formal public input opportunities are provided by public meetings held by an agency. Agency activity records should contain information for this indicator. Types of public meetings may be specified (e.g., regulation changes, land acquisition, major policy changes).

2A-5.b. Number of people attending public meetings.

Sources: Gray and Larson (1982) (2), Wyoming (1984) (1)

Appropriateness: High

Availability: High

Public meeting attendance is counted at each meeting. These data may be filed with other records regarding the meetings. Attendance at each type of meeting (as in 2A-5.a) may be specified to indicate which topics appear to generate the most public interest.

2A-6: Law Enforcement

2A-6.a. Number of licensed hunters and anglers per full-time enforcement officer.

Sources: Nelson and Verbyla (1984) (2)

Appropriateness: High

Availability: High

These data should be available in agency personnel records and license sales records. This measure indicates the potential workload faced by enforcement personnel. It may be used in conjunction with other indicators in this section to determine the relation between workloads and other measures of enforcement activities.

2A-6.b. Number of public contacts by law enforcement officers.

Sources: Giles (1978) (3), Arizona (1981) (1), Glover (1982) (2), Tennessee (1982) (1), Virginia CGIF (1982) (1)

Appropriateness: High

Availability: High

Officer work reports should contain this information. The type of contact may be specified (e.g., creel check, information request, permit check). Refining the indicator in this way would allow assessing the relative frequency with which officers encounter the public for each purpose. This measure may be used in conjunction with others in this section to determine the relationship between the number of public contacts and other law enforcement activities.

2A-6.c. Number of arrests or citations issued.

Sources: Giles (1978) (2), Cowles (1979) (2), Glover (1982) (2), Virginia CGIF (1982) (1), Phelps and Melvin (1983) (3), Nelson and Verbyla (1984) (2), Wyoming (1984) (1)

Appropriateness: High

Availability: High

These data should be available in records of the law enforcement division. This indicator may be further refined by categorizing citations by county or management area, species involved, and type of violation. This indicator has been criticized as being too sensitive to changes in administrative policy (Cowles

et al. 1978). By categorizing citations, effects of policy changes on number issued may be more apparent.

2A-6.d. Number of convictions obtained per arrest.

Sources: Ritter (1975) (3), Giles (1978) (2), Glover (1982) (2), Nelson and Verbyla (1984) (2), Wyoming (1984) (1).

Appropriateness: High

Availability: High

Law enforcement division records or judicial records should contain this information. A high number of convictions per arrest indicates officers are making arrests in situations where violations are apparent. A low number of convictions per arrest indicates officers are making arrests in situations where the evidence is not great or are issuing citations as "warnings" rather than giving only a verbal warning.

2A-6.e. Amount of fines collected as a result of violation convictions.

Sources: Arizona (1981) (1), Glover (1982) (2), Virginia CGIF (1982) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

State court records should contain this information. Fines for convictions indicate the severity of the violation. Con-

victions may be classified according to type of violation as with the other indicators in this section. This indicator may be used in conjunction with others in this section to determine the average fine per type of conviction.

2A-6.f. Percent of agency employees who are enforcement officers.

Sources: Glover (1982) (2)

Appropriateness: High

Availability: High

Agency personnel records should contain this information. This measure may be used to compare the importance of enforcement with other agency activities based on the number of employees involved.

2A-6.g. Percent of agency budget devoted to law enforcement activities.

Sources: Glover (1982) (2), Healey (1984) (3)

Appropriateness: High

Availability: High

This information should be available in agency fiscal records. Relative emphasis on law enforcement in agency functions may be assessed with this measure.

2A-6.h. Number of phone calls received reporting violations.

Sources: Cowles et al. (1978) (2), Giles (1978) (3), Arizona (1981) (1), Glover (1982) (2), Nelson and Verbyla (1984) (2)

Appropriateness: Moderate

Availability: High

2A-6.i. Number of times enforcement officers were called upon for witness testimony.

Sources: Arizona (1981) (1)

Appropriateness: Moderate

Availability: High

2A-6.j. Average value of agent politeness scale as judged by resource users.

Sources: Ritter (1975), Giles (1978) (2)

Appropriateness: Moderate

Availability: Low

2A-7: Research: People

2A-7.a. Amount of money committed to user-related research.

Sources: National Science Board (1981) (2), Miller et al. (1983) (3), Weber and Horak (1983) (3)

Appropriateness: High

Availability: High

Agency fiscal records should contain this information. This indicator may be compared with other indicators in sections 2B-1 and 2C-2 to assess the relative research emphasis on user concerns.

2A-7.b. Percent of personnel time spent on user-related research.

Sources: Arizona (1981) (1)

Appropriateness: High

Availability: High

Data should be available in personnel activity reports. This indicator may be used to assess the relative importance (in terms of personnel time) assigned to user research in comparison with other agency activities.

2A-7.c. Number of research studies addressing users.

Sources: Oregon (1982) (1), Wyoming (1984) (1)

Appropriateness: Moderate

Availability: High

2A-7.d. Number of personnel assigned to user-related research.

Sources: Weber and Horak (1983) (3)

Appropriateness: High

Availability: High

This information should be available in agency personnel records. This indicator may be used to assess the relative importance (in terms of personnel) assigned to user research in comparison with other agency activities.

3A: OUTPUTS-PEOPLE

3A-1: Recreation Opportunities: Quantity

3A-1.a. Percent of state population participating in fisheries and wildlife-related opportunities.

Sources: Peine et al. (1980) (2), Commonwealth of Virginia (1984) (1)

Appropriateness: High

Availability: Moderate

Fisheries and wildlife-related recreation opportunities include activities which are enhanced by fish and wildlife organisms, but not necessarily dependent upon them. These activities include: driving for pleasure, walking for pleasure, boating, using nature trails, outdoor photography, wilderness camping, hiking, visiting zoos. These data may be available in results of Statewide Comprehensive Outdoor Recreation Planning (SCORP) surveys, on a limited basis through the Resource Planning process of the U.S. Forest Service, or in the 5-year surveys conducted by the U.S. Fish and Wildlife Service. If no data are available, a survey would be necessary. With this information, an indication of the importance of fish and wildlife to statewide outdoor recreation is available. Efforts may be

targeted to increase this incidental use of fish and wildlife by the general populace and also to stimulate more direct uses.

3A-1.b. Number of privately-owned fish and wildlife recreation enterprises in state.

Sources: Epperson (1980) (2)

Appropriateness: High

Availability: Moderate

This measure indicates the provision of recreation opportunities by the public sector. Data should be available in records of the state business administration.

3A-1.c. Rank of direct fisheries and wildlife recreation among all recreation pursuits in state, in terms of participation.

Sources: Peine et al. (1980) (2)

Appropriateness: High

Availability: Low

A survey would be necessary to determine the number of people participating in all forms of recreation. This information may be available from state recreation agencies on an irregular basis. Recreation directly related to wildlife includes consumptive activities such as fishing and hunting, and nonconsumptive activities such as birdwatching and wildlife

photography. The relative importance of wildlife recreation compared to other recreation activities is made apparent.

3A-1.d. Percent of all state recreation user-days attributable to fish and wildlife.

Sources: Commonwealth of Virginia (1984) (1), USFS (1984) (1)

Appropriateness: High

Availability: Low

3A-1.e. Number of recreationists of all types using state wildlife management areas.

Sources: Wyoming (1984) (1)

Appropriateness: High

Availability: Low

3A-2: Consumptive Use: Quantity

3A-2.a. Percent of population participating in consumptive resource uses, determined by harvest license sales.

Sources: Bennett et al. (1978) (3), Charbonneau and Lyons (1980) (2), Peine et al. (1980) (2), USFWS (1980) (1), Arizona (1981) (1), Everest and Summers (1982) (2), Oregon (1982) (1), Wyoming (1984) (1), Stephenson (1985) (2)

Appropriateness: High

Availability: High

These data should be quite available in license sale records and state population records. Consumptive uses are easily identified from licenses according to type of user (e.g., in-state, out-of-state), type of use (e.g., fishing, trapping, commercial harvest), and often type of program (e.g., trout stream management). Unlicensed recreationists (legal or illegal) are not accounted for by this method. Stephenson (1985) noted that the ratio of licensed to unlicensed anglers is relatively constant. If this is true for all types of consumptive uses, and if the proportion of license buyers who actually participate remains constant, this indicator will be a consistent measure of relative participation from year to year.

3A-2.b. Number of consumptive users as measured by license sales.

Sources: Peine et al. (1980) (2), Arizona (1981) (1), Everest and Summers (1982) (2), Missouri (1982) (1), Oregon (1982) (1), Tennessee (1982) (1), Outdoor Recreation Policy Review Group (1983) (2), Florida (1984) (1), Wyoming (1984) (1), Kansas (1985) (1), Maryland (1985) (1), Snepenger and Ditton (1985) (2), USDC (1985c) (1)

Appropriateness: High

Availability: High

These data should be available in records of license sales. License type, user type, and program type may be specified, as in 3A-2. a. The total number of users may complement the in-

formation available in indicator 3A-2. a. Although the percent of a population using the resource may remain constant, if the population is increasing the result is an increasing actual number of users. This has consequences for management in terms of the availability of resources, possible overuse, and potential for user conflicts. It also signifies more consumptive recreation opportunities are being used than in the past, which might not be apparent by examining only percent participation.

3A-2.c. Number of boats participating in commercial fishery.

Sources: Oregon (1982) (1)

Appropriateness: High

Availability: High

These data should be available in agency permit records. This measure indicates the degree of participation in commercial use of fisheries resources. This indicator may be refined by considering the length of participation (e. g. , days).

3A-2.d. Number of days spent charter boat fishing.

Sources: Brusher et al. (1984) (2)

Appropriateness: High

Availability: Moderate

3A-2.e. Percent of population participating in consumptive resource use, determined by survey.

Sources: Charbonneau and Lyons (1980) (2)

Appropriateness: High

Availability: Moderate

3A-2.f. Number of consumptive users, determined by survey.

Sources: Charbonneau and Lyons (1980) (2)

Appropriateness: High

Availability: Moderate

3A-2.g. Number of recreation days provided by consumptive use of the resource.

Sources: Idaho (1978) (1), Arizona (1981) (1), Cordell and Hartmann (1982) (3), Everest and Summers (1982) (3), Florida (1984) (1), Healey (1984) (3), O'Bara and Estes (1984) (2), Wyoming (1984) (1), Kansas (1985) (1), Maryland (1985) (1), Snepenger and Ditton (1985) (2)

Appropriateness: High

Availability: Low

3A-2.h. Number of days spent afield per animal harvested.

Sources: Idaho (1978) (1), Arizona (1981) (1), Missouri (1982) (1), Oregon (1982) (1), Virginia CGIF (1982) (1), Florida (1984) (1), Wyoming (1984) (1), Kansas (1985) (1), Maryland (1985) (1)

Appropriateness: High

Availability: Low

3A-2.i. Percent of total recreation days in state provided by consumptive use.

Sources: Idaho (1978) (1)

Appropriateness: High

Availability: Low

3A-3: User Knowledge/Awareness

3A-3.a. Number of unsolicited public requests received for agency information and education materials.

Sources: Giles (1978) (3), Wyoming (1984) (1)

Appropriateness: High

Availability: High

Agency information and education division records should have these data available. Unsolicited requests for information indicate an interest in learning about agency activities and resource information. These requests may be categorized according to subject matter or form of information (e.g., publication, film).

3A-3.b. Number of subscribers to agency magazine.

Sources: Arizona (1981) (1), Oregon (1982) (1), Virginia CGIF (1982) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

Personal magazine subscription records should be available in agency files. Subscribing to the agency magazine indicates an interest in learning more about the agency and the resource. Use of personal, corporate, and library codes on subscription records would facilitate sorting out the types of subscriptions.

3A-3.c. Number of people attending agency presentations.

Sources: Wyoming (1984) (1)

Appropriateness: High

Availability: High

Attendance at presentations indicates a willingness to learn more about the agency and the resource. This measure is a direct indicator of user awareness. It takes more effort to attend a presentation than to receive a magazine at home. Whether a magazine is read or not cannot be measured easily. Attendance and participation at a presentation are easily noted. Presentations may be grouped according to type (e.g., school programs, camp programs, hunter education workshops). Attendance may be counted at each presentation, and summed for the year.

3A-3.d. Number of people trained or certified by agency.

Sources: Arizona (1981) (1), Missouri (1982) (1), Pettus and Auldridge (1984) (2), Wyoming (1984) (1), Benson (1985) (2), Kansas (1985) (1), Maryland (1985) (1)

Appropriateness: High

Availability: High

Type of instruction may be specified (e.g., hunter education students, Project Wild instructors). This information should be available in activity records of the information and education division.

3A-3.e. Number of schools offering formal wildlife education curricula.

Sources: Arizona (1981) (1), Missouri (1982) (1), Pettus and Auldridge (1984) (3)

Appropriateness: High

Availability: Moderate

3A-3.f. Number of accidents reported in recreation pursuits for which there exists a safety education program.

Sources: Arizona (1981) (1), Virginia CGIF (1982) (1), Eriksen et al. (1985) (3)

Appropriateness: High

Availability: Moderate

3A-3.g. Percent of hunter training course participants who subsequently purchase a license.

Sources: Decker and Brown (1982) (2)

Appropriateness: High

Availability: Moderate

3A-3.h. Recreation-related fatality rate as percent of national average.

Sources: Kansas (1985) (1)

Appropriateness: High

Availability: Moderate

3A-3.i. Percent change in ecological knowledge after a wildlife-related experience.

Sources: Pearsall (1984) (3)

Appropriateness: High

Availability: Low

3A-3.j. Percent of news releases (by number or topic) distributed which were actually used by the media.

Sources: Wyoming (1984) (1)

Appropriateness: High

Availability: Low

3A-4: Recreation Opportunities: Type

3A-4.a. Percent of total fisheries and wildlife-related recreation spent in each activity type.

Sources: Kansas (1985) (1)

Appropriateness: High

Availability: Moderate

Activities may be classified as listed in 3A-1.a, 3A-2, and 3A-6. Data for this indicator should be available in the 5-year surveys performed by the U.S. Fish and Wildlife Service. A survey would be necessary to gather this information yearly. Percent of time spent in each activity type allows a ranking of activities in terms of popularity judged by actual use. This indicator may be used in conjunction with measures of opportunities actually available to determine if some activities are under- or over-used.

3A-4.b. Percent of recreation days spent in each type of area.

Sources: Cordell and Hartmann (1982) (2)

Appropriateness: High

Availability: Low

Surveys would be necessary to gather this information. Recreation areas may be categorized according to ownership type

(e.g., federal, state, county, private) or use type (e.g., fishing lakes, hunting areas, nature trails).

3A-4.c. Percent of privately-owned outdoor recreation enterprises which are oriented toward fisheries and wildlife recreation.

Sources: Epperson (1980) (3)

Appropriateness: High

Availability: Low

3A-5: Consumptive Use: Type

3A-5.a. Consumptive recreation participation measured as a percent of recreationists who hunt only, fish only, or hunt and fish.

Sources: Snepenger and Ditton (1985) (2)

Appropriateness: High

Availability: Moderate

These data are available every 5 years in the surveys conducted by the U.S. Fish and Wildlife Service, or by cross-checking state license records. This measure indicates the relative popularity of the two major consumptive uses, fishing and hunting.

3A-5.b. Percent of all consumptive effort (user-days) devoted to a particular species or group of species.

Sources: Idaho (1978) (1), Kansas (1985) (1)

Appropriateness: High

Availability: Moderate

These data may be available through an examination of license sales and reported catch records, or through the 5-year survey conducted by the U.S. Fish and Wildlife Service. Species or groups of species (e.g., big game) may be specified to determine relative effort spent on each harvest target.

3A-5.c. Percent of harvest taken with each gear type.

Sources: Oregon (1982) (1)

Appropriateness: High

Availability: Low

3A-6: Nonconsumptive Use: Quantity

3A-6.a. Number of visitors to wildlife refuges or reserve areas where consumptive use is not allowed.

Sources: Jenkins (1972) (3)

Appropriateness: High

Availability: Moderate

One method for collecting this information would be the use of traffic surveys or counters conducted at reserve entrance areas. This indicator provides a measure of use solely related

to nonconsumptive wildlife enjoyment, as consumptive activities are prohibited.

3A-6.b. Number of visitors to fish hatcheries.

Sources: Idaho (1978) (1)

Appropriateness: High

Availability: Moderate

Visitation records at hatcheries may contain this information. While this is a specific nonconsumptive use, it is quite appropriate for measuring nonconsumptive use of fishes.

3A-6.c. Number of nonconsumptive users in state, measured by survey.

Sources: Florida (1984) (1)

Appropriateness: High

Availability: Moderate

These data are available every 5 years in a survey conducted by the U.S. Fish and Wildlife Service. For intervening years, however, a separate survey would be required. Types of nonconsumptive use may be identified (e.g., at residence, away from home, photography, feeding).

3A-6.d. Percent of population participating in nonconsumptive activities, determined by survey.

Sources: More (1979) (2), Peine et al. (1980) (3), Commonwealth of Virginia (1984) (1)

Appropriateness: High

Availability: Moderate

These data are available in the 5-year surveys conducted by the U. S. Fish and Wildlife Service, but must be compared with state population records to determine percent of population. Types of nonconsumptive use may be identified as in 3A-6.c.

3A-6.e. Total number of recreation days spent in nonconsumptive activities.

Sources: Cordell and Hartmann (1982) (3), Virginia CGIF (1982) (1) Florida (1984) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: Low

3A-6.f. Number of people who purchased equipment used in nonconsumptive wildlife activities.

Sources: Shaw and Mangun (1984) (3)

Appropriateness: High

Availability: Low

3A-6.g. Number of people donating to nongame program.

Sources: Kansas (1985) (1)

Appropriateness: Moderate

Availability: High

3A-6.h. Percent of population donating to nongame program.

Sources: Kansas (1985) (1)

Appropriateness: Moderate

Availability: High

3A-6.i. Number of visitors to zoos.

Sources: More (1979) (2)

Appropriateness: Moderate

Availability: High

4A: IMPACTS-PEOPLE

4A-1: Economic Influences

4A-1.a. Expenditures of recreationists in pursuit of fisheries and wildlife-related opportunities.

Sources: Charbonneau and Hay (1978) (3), Idaho (1978) (1), Tennessee (1982) (1), Menz and Wilton (1983) (2), Florida (1984) (1), Shaw and Mangun (1984) (2), Wyoming (1984) (1), Maryland (1985) (1)

Appropriateness: High

Availability: Moderate

Expenditures of recreationists may be determined empirically with survey techniques. Data may be available from the U.S. Travel Data Center in the U.S. Travel Data Bank, and from the 5-year survey conducted by the U.S. Fish and Wildlife Service. It is difficult to determine what portion of expenditures on fisheries and wildlife recreation would be made even in the absence of fisheries and wildlife recreation opportunities. As an indicator of the current impact on the state economy, however, expenditure information does measure the amount of money actually contributed to the economy. Expenditures may be categorized by type of activity (e.g., consumptive, hunting, observing).

4A-1.b. Amount of money contributed to economy by recreationists for each dollar spent by agency.

Sources: Kansas (1985) (1)

Appropriateness: High

Availability: Moderate

This indicator builds upon information reported in 4A-1.a. Agency fiscal records or indicator 2D-4.a should contain the remainder of information necessary. This measure indicates the "return on investment" received by the state in general from expenditures by the agency.

4A-1.c Value of commercial fisheries and wildlife products.

Sources: Idaho (1978) (1), Oregon (1982) (1), Tennessee (1982) (1), Virginia MRC (1982) (1), Bronte and Johnson (1984) (3), Florida (1984) (1), Maryland (1985) (1), USDC (1985b) (1)

Appropriateness: High

Availability: Moderate

Data for this indicator may be available in commercial sale records reported to an agency. Type of product may be specified (e.g., fur pelts, food fish).

4A-1.d. Amount of money contributed to economy by recreationists per animal harvested.

Sources: Wyoming (1984) (1)

Appropriateness: High

Availability: Moderate

4A-1.e. National rank in total value of the commercial dockside catch.

Sources: Virginia MRC (1982) (1)

Appropriateness: High

Availability: Moderate

4A-1.f. Percent of jobs in state directly related to fisheries and wildlife-based recreation.

Sources: Tennessee (1982) (1), Virginia MRC (1982) (1), Outdoor Recreation Policy Review Group (1983) (2), Healey (1984) (3)

Appropriateness: High

Availability: Low

4A-2: Agency Perception

4A-2.a. Number of congressional inquiries regarding agency activities.

Sources: Giles (1978) (3)

Appropriateness: High

Availability: High

Congressional inquiries regarding the affairs of a public agency are usually brought about by public or congressional concern about the way an agency is performing its duties. These data should be available in docket records of the state legislature and agency correspondence files.

4A-2.b. Ratio of positive to negative unsolicited public comments received by an agency regarding management activities.

Sources: Gray and Larson (1982) (3)

Appropriateness: High

Availability: Moderate

These data may be available in agency records (information division), or dispersed throughout an agency depending on how public comments are handled. Unsolicited comments may be categorized according to type (e.g., phone call, letter), subject (e.g., personnel, harvest, habitat quality), or program (e.g., big game).

4A-2.c. Ratio of positive to negative press for an agency.

Sources: Duttweiler (1985) (2)

Appropriateness: High

Availability: Moderate

These data are available in state and local newspapers, but would have to be compiled to be of use. Press-clipping services

perform this function, but clippings must then be rated positive or negative. Press comments may be categorized according to subject or program, as in 4A-2.b. Comments in the press have a different impact than do individual comments from the public as in 4A-2.b. Comments in the press may be from users who are somewhat more informed (e.g., sportswriters) because of the number of contacts they have within an agency. Regular outdoors columns, editorials, and letters from citizens may be addressed with this measure. These comments tend to have a broader influence on the general public, as their presence in a newspaper may sway the opinion of readers regarding an agency.

4A-2.d. Number of public comments received regarding agency actions affecting wildlife.

Sources: Gray and Larson (1982) (3)

Appropriateness: High

Availability: Moderate

4A-2.e. Amount of money donated to agency per dollar spent on publicity.

Sources: Henderson (1984) (3)

Appropriateness: High

Availability: Moderate

4A-2.f. Percent of eligible taxpayers donating to agency through tax checkoff program.

Sources: Carrothers and Knight (1984) (3), Henderson (1984)
(3)

Appropriateness: High

Availability: Moderate

4A-2.g. Number of corporations donating advertising space to agency.

Sources: Henderson (1984) (3)

Appropriateness: Moderate

Availability: High

4A-2.h. Number of local proclamations of national hunting and fishing day.

Sources: Missouri (1982) (1)

Appropriateness: Moderate

Availability: Moderate

4A-3: Organized Club Affiliation

4A-3.a. Number of clubs and organizations receiving an agency newsletter.

Sources: Maryland (1985) (1)

Appropriateness: High

Availability: High

Agency information division records should contain this information. Type of organization may be specified as in 4A-3.a. This measure indicates the extent of formal contact between citizen groups and an agency.

4A-3.b. Number of current memberships in local, state, or national nature clubs, recreation groups, conservation organizations, or animal welfare societies.

Sources: Dahlgren et al. (1977) (3), Hay and McConnell (1979) (3), More (1979) (3), Burch (1980) (3), Gray and Larson (1982) (2)

Appropriateness: High

Availability: Moderate

These data should be available from the clubs and organizations addressed. Type of organization may be specified (e.g., pro-hunting, anti-hunting, nature study).

4A-4: Personal Benefits

4A-4.a. Percent of resource users experiencing each type of personal benefit.

Sources: Ferriss (1970) (3), Walsh et al. (1984) (3)

Appropriateness: High

Availability: Low

A survey of resource users would be necessary to determine this information. Possible personal benefits are many, and include such things as spiritual inspiration, escape from pressure, learning about nature, being with others, improving health and fitness, financial gain, improving outlook on life, and simply having fun.

4A-4.b. Percent of resource users returning to same site of previous use.

Sources: Brotherton (1982) (2)

Appropriateness: Moderate

Availability: Low

A survey would be necessary to obtain this information from resource users. This measure is based on the assumption that if a person returns to a site, some personal benefit must have been derived the previous time and probably will be again. Types of personal benefit are not identified with this indicator.

4A-5: Societal Benefits

4A-5.a. Percent of resource users experiencing each type of societal benefit.

Sources: Peine et al. (1980) (3)

Appropriateness: High

Availability: Low

This measure would require a survey of resource users. Societal benefits that are experienced at the individual level include such things as greater worker productivity, greater family solidarity, and decreased tendency toward violent behavior.

4A-5.b. Number of resource-related outings arranged in state for special social groups.

Sources: Pearsall (1984) (3)

Appropriateness: Moderate

Availability: Moderate

Special groups include juvenile delinquents, troubled youth or adults, handicapped, inner city inhabitants, or others who may not have an opportunity to experience fisheries and wildlife recreation on their own. Societal benefits may accrue if these resource users are stimulated in some way to become more productive or more content members of society. These data may be available from the information division of an agency, or from organizations providing assistance for these social groups.

4A-5.c. Percent of people satisfied with their fisheries and wildlife resource use and knowledge.

Sources: Allen and Beattie (1984) (3), Snepenger and Ditton (1985) (3)

Appropriateness: Moderate

Availability: Low

A survey would be necessary to obtain these data. Satisfaction with leisure and recreation activities and one's surroundings often correlates with a satisfaction with community life. Those satisfied with community life are usually least disruptive of societal norms.

4A-5.d. Rate of violation of agency regulations.

Sources: Ritter (1975) (3), Giles (1978) (3)

Appropriateness: Moderate

Availability: Low

4A-5.e. Number of illegally killed animals.

Sources: Huff (1982) (3)

Appropriateness: Moderate

Availability: Low

4A-6: User Conflicts.

4A-6.a. Number of hunting accidents reported per season.

Sources: Ritter (1975) (3), Bisselle et al. (1971) (3)

Appropriateness: High

Availability: High

Hunting accidents for this measure include situations in which two or more people are involved. Accidents are a measure of the physical overcrowding of hunting areas. These data should be available in agency records.

4A-6.b. Number of editorials or articles in newspapers addressing user conflicts.

Sources: B. Knuth (4)

Appropriateness: High

Availability: Moderate

A search of state and local newspapers would be necessary to gather this information. Type of conflicts may be specified (e.g., hunter-hunter, landowner-hunter).

1B: INPUTS-POPULATIONS

1B-1: Populations: Quantity

1B-1.a. Number of species occurring in state, by type.

Sources: Idaho (1978) (1), Oregon (1982) (1), Kansas (1985) (1), Rafe et al. (1985) (2)

Appropriateness: High

Availability: Moderate

Species may be categorized as to management type; for example, big game, waterfowl, furbearers, nongame, game fish. Data for this indicator may be obtained from department research and inventory records as well as from a general survey of field biologists. It is likely all species occurring in a state may not be identified unless specific inventory work has been completed, but field biologists are probably aware of most species for this type of assessment. States with computerized information systems should find these data very available.

1B-1.b. Percent of species in state with increasing, decreasing, and stable numbers.

Sources: Wyoming (1984) (1)

Appropriateness: High

Availability: Moderate

Data for this indicator will be available if population assessments (see 3B-3) have been completed for a number of years. If no such assessments have been done, gathering data for this indicator would require a substantial inventory effort, thus decreasing the potential availability of the indicator. Groups of species may be targeted with this indicator, as in 1B-1.a. For example, percent of big game species increasing (or decreasing) may be of interest to an agency.

1B-1.c. Number of animals in post-harvest populations for each harvested species.

Sources: Wyoming (1984) (1)

Appropriateness: High

Availability: Low

1B-1.d. Percent of species in state with at least minimum viable population sizes.

Sources: LaCava and Hughes (1984) (3)

Appropriateness: Moderate

Availability: Low

1B-2: Populations: Requirements

1B-2.a. Number of species for which status surveys have been conducted in the last 5 years.

Sources: Michigan (1984) (1)

Appropriateness: High

Availability: High

This indicator demonstrates the availability of current information for various species. Particular taxonomic groups (e.g., fish) or management programs may be targeted (e.g., big game program). These data should be available in agency activity records.

1B-2.b. Percent of species within a state for which life history requirements are known.

Sources: B. Knuth (4)

Appropriateness: High

Availability: Moderate

Knowledge of a species' requirements throughout its life is an important input to any management activities involving that species. This indicator may be applied to managed species only, grouped according to type of use (e.g., furbearers), or to all species potentially affected by management activities. Gathering data for this indicator would entail a count of published or other research reports in which life history characteristics are documented. For states with computer-based information management systems, these data should be easily obtainable.

1B-2.c. Percent of species within a state for which habitat suitability curves exist.

Sources: B. Knuth (4)

Appropriateness: High

Availability: Moderate

Habitat suitability curves (e.g., Allen 1982) are a useful way to summarize information on a species' requirements. Groups of species may be targeted specifically as in 1B-2.a. A literature search of published and unpublished research and agency reports would be required to gather data on this indicator.

1B-3: Populations: Distributions

1B-3.a. Number of counties with reported occurrence of each species of interest.

Sources: Council on Environmental Quality (1981) (2), Tennessee (1982) (1), Florida (1984) (1), O'Bara and Estes (1984) (3), Kansas (1985) (1), McElveen (1985) (3)

Appropriateness: High

Availability: Moderate

All species present in a state may be assessed, or only those for which there is a particular management interest (e.g., songbirds, furbearers). Data are likely available through a

survey of field biologists in the state. Harvest records indicating county of take may be a useful data source for consumed species. States with computerized information systems should find these data highly available.

1B-3.b. Percent of former range occupied by a species.

Sources: Urich and Cannon (1985) (2)

Appropriateness: High

Availability: Moderate

Research on former ranges of species of interest could be coupled with information gathered for indicator 1B-3.a to provide data for this indicator. "Former range" is left open to definition depending on the species and the state. It may refer to such situations as pre-settlement range, pre-urbanization range, or range 50 years ago. Choosing species of concern is also left to state discretion. For example, species may be selected on the basis of available information, management importance, ecological importance, or human interest.

1B-3.c. Number of watersheds with reported occurrence of each species of interest.

Sources: Florida (1984) (1), Judy et al. (1984) (3), O'Bara and Estes (1984) (3)

Appropriateness: High

Availability: Moderate

1B-3.d. Animal densities (numbers/acre or numbers/ha) for species of interest in each region of state (county, management district).

Sources: Tennessee (1982) (1), Maryland (1985) (1)

Appropriateness: High

Availability: Low

1B-4: Populations: Type

1B-4.a. Number of species under agency management in each taxonomic or management group.

Sources: Oregon (1982) (1), Florida (1984) (1), Maryland (1985) (1)

Appropriateness: High

Availability: High

Taxonomic groups could include, for example, vertebrates, mammals, birds, fishes. Management groups could include furbearers, game fish, and nongame. Data gathering for this indicator should require only a simple listing process by managers or biologists of those species for which they undertake management activities.

1B-4.b. Percent of species in state which are in each management category.

Sources: Florida (1984) (1)

Appropriateness: High

Availability: Moderate

An example of this indicator is the percent of mammal species in a state classified as furbearers. Management categories may include game, nongame, furbearers, big game, waterfowl, game fish, endangered, and commercial. Data gathering would require a master list of species in the state and a listing of species addressed in each management category. The latter would likely be available through a survey of management biologists. States with computerized information systems should find these data highly available.

2B: PROCESSES-POPULATIONS

2B-1: Research: Populations

2B-1.a. Amount of money committed to research addressing animal populations.

Sources: National Science Board (1981) (2), Miller et al. (1983) (2), Weber and Horak (1983) (2)

Appropriateness: High

Availability: High

This information should be available in agency fiscal records. This indicator may be compared with other indicators in sections 2A-7 and 2C-2 to assess the relative research emphasis on animal populations.

2B-1.b. Percent of personnel time spent on population research.

Sources: Arizona (1981) (1), Weber and Horak (1983) (2)

Appropriateness: High

Availability: High

Personnel activity reports should contain this information. This indicator may be used to assess the relative importance given research on animal populations in terms of staff time.

2B-1.c. Number of research studies addressing animal populations.

Sources: Hay and McConnell (1979) (3), Arizona (1981) (1),
Missouri (1982) (1), Oregon (1982) (1), Virginia CGIF (1982)
(1), Wyoming (1984) (1)

Appropriateness: Moderate

Availability: High

2B-1.d. Number of personnel assigned to research on animal populations.

Sources: Arizona (1981) (1)

Appropriateness: Moderate

Availability: High

2B-2: Population Manipulation

2B-2.a. Number of projects undertaken to manipulate wildlife population densities.

Sources: Giles (1978) (3), Michigan (1984) (1)

Appropriateness: High

Availability: High

This information should be available in agency activity reports. Projects may be categorized according to type (e.g., use of attractants or repellants, removal or introductions), purpose (e.g., change sex ratio, regulate disease), species,

or management program. Stage of completion of project may also be specified (e.g., completed, ongoing, terminated, proposed). This indicator shows the emphasis on population manipulation activities.

2B-2.b. Number of animals trapped and relocated.

Sources: Tennessee (1982) (1), Virginia CGIF (1982) (1)

Appropriateness: High

Availability: High

Information for this indicator should be available in agency activity reports. This indicator may be refined by noting the number of animals in each species which were trapped and relocated.

2B-2.c. Number of days of supplemental feeding programs for wildlife populations.

Sources: Giles (1978) (3), Wyoming (1984) (1)

Appropriateness: High

Availability: High

This information should be available in agency activity reports. Particular species may be identified. Purpose of feeding program may also be specified (e.g., concentrate groups of animals, supplement winter forage).

2B-2.d. Percent of personnel time spent on population manipulation activities.

Sources: Arizona (1981) (1)

Appropriateness: High

Availability: High

Personnel work reports should contain this information. This measure indicates the relative importance of population manipulation activities compared to other resource management activities, in terms of staff time.

2B-2.e. Number of population inventories completed and/or ongoing.

Sources: Arizona (1981) (1)

Appropriateness: Moderate

Availability: High

2B-3: Stocking

2B-3.a. Number of individuals stocked.

Sources: USFWS (1980) (1), Arizona (1981) (1), Missouri (1982) (1), Oregon (1982) (1), Virginia CGIF (1982) (1), O'Bara and Estes (1984) (2), Wyoming (1984) (1)

Appropriateness: High

Availability: High

Agency activity records should contain this information. This indicator may be refined by categorizing individuals stocked according to species, size, program, or management district. This indicator may be used in conjunction with others in section 3-B to assess the relationship between stocking activities and later harvests.

2B-3.b. Weight of animals stocked (pounds).

Sources: Oregon (1982) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

This information should be available in agency activity reports. Categories may be used for this indicator as in 2B-3.a. This indicator is most appropriate for fisheries management, where harvest is often specified in terms of weight.

2B-3.c. Number of areas stocked.

Sources: Judy et al. (1984) (3)

Appropriateness: High

Availability: High

Agency activity records should contain this information. Areas stocked may be categorized according to the type or area (e.g., streams, ponds, lakes, wildlife management areas).

2B-3.d. Number of animals distributed in cooperative raise-and-release programs.

Sources: Oregon (1982) (1)

Appropriateness: High

Availability: High

In cooperative raise and release programs, an agency distributes young (e.g., pheasant chicks) to landowners. Landowners raise these animals, then release them onto their property to increase hunting opportunities. Information for this indicator should be available in agency activity records.

2B-3.e. Percent of personnel time devoted to hatchery operation and stocking activities.

Sources: Arizona (1981) (1)

Appropriateness: High

Availability: High

Personnel activity records should contain this information. This indicator may be compared with the amount of staff time spent in other activities to assess the relative emphasis placed on each activity.

2B-3.f. Number of animals stocked by sources other than the management agency.

Sources: Maryland (1985) (1)

Appropriateness: High

Availability: Moderate

2B-3.g. Number of hatchery or rearing facilities operated.

Sources: Missouri (1982) (1), Oregon (1982) (1)

Appropriateness: Moderate

Availability: High

2B-3.h. Number of hatchery inspections performed.

Sources: Oregon (1982) (1), Wyoming (1984) (1)

Appropriateness: Moderate

Availability: High

2B-4: Damage/Depredation Control

2B-4.a. Number of damage complaints investigated.

Sources: Oregon (1982) (1)

Appropriateness: High

Availability: High

Information for this indicator should be available in agency activity records. Complaints may be categorized according to species involved or type of damage (e.g., apple orchard). This indicator may be used in conjunction with others in this section

or with those in section 4B-1 to assess the relationship between complaints investigated and other damage-related concerns.

2B-4.b. Number of animals transplanted or killed due to damage complaints.

Sources: Council on Environmental Quality (1981) (2), (1982) (2); Oregon (1982) (1)

Appropriateness: High

Availability: High

Agency activity records should contain this information. This indicator may be refined by specifying the species involved or type of complaint.

2B-4.c. Amount of money distributed for wildlife damage claims.

Sources: Dorrance (1983) (3), Michigan (1984) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

Agency fiscal records should contain this information. These data should be collected on a statewide basis. Damage claim payments may be categorized according to type of claim or species involved.

2B-4.d. Percent of personnel time devoted to animal damage prevention, investigation, and control.

Sources: Wyoming (1984) (1)

Appropriateness: High

Availability: High

This information should be available in personnel activity reports. Percent of time devoted to prevention, investigation or damage appraisal, and control may be compared to assess the relative importance of the three activities. This indicator may also be compared with similar indicators based on personnel time to compare relative importance of different activities.

2B-4.e. Percent of depredation complaints answered by public cooperators in agency damage control program.

Sources: Missouri (1982) (1), McKegg (1984) (2)

Appropriateness: High

Availability: Moderate

2B-5: Species Introductions

2B-5.a. Number of requests for introduced species permits investigated.

Sources: Arizona (1981) (1)

Appropriateness: High

Availability: High

Agency activity records should contain this information. Type of area (e.g., reservoir) and species may be specified.

2B-5.b. Percent of personnel time spent in animal introduction work.

Sources: Arizona (1981) (1)

Appropriateness: High

Availability: High

This information should be available in personnel activity reports. Relative importance of this activity may be assessed by comparing this indicator with similar indicators for other activities.

2B-5.c. Number of permits issued for introducing species.

Sources: Giles (1978) (3)

Appropriateness: High

Availability: High

Agency permit records should contain this information. Types of species and habitat may be specified, along with type of permit (e.g., hold, release).

2B-6: Animal Rehabilitation

2B-6.a. Number of rehabilitation permits issued.

Sources: Tennessee (1982) (1), McKegg (1984) (2)

Appropriateness: High

Availability: High

Some states require private individuals or groups to obtain a permit which allows them to keep and rehabilitate injured wildlife. In such cases, information for this indicator would be available in agency records. This measure indicates the amount of interest in rehabilitating wildlife as well as the need (real or perceived) for rehabilitation efforts.

2B-6.b. Number of agency interactions with wildlife rehabilitation centers.

Sources: Oregon (1982) (1)

Appropriateness: High

Availability: High

Type of interaction may be specified (e.g., requests for information from centers, inspections, delivery of injured wildlife). This information should be available in personnel activity records.

2B-6.c. Number of animals treated in rehabilitation centers or programs.

Sources: McKegg (1984) (2)

Appropriateness: High

Availability: High

This information should be available in permit records or rehabilitation center records. This indicator may be refined by categorizing animals by species or type of injury.

2B-6.d. Percent of rehabilitated wildlife in each type of outcome.

Sources: McKegg (1984) (2)

Appropriateness: High

Availability: High

This information should be available in records of the rehabilitation centers. Species and type of injury may be specified. Outcomes may include returning animals to the wild, using animals for research, or displaying animals in zoos.

3B: OUTPUTS-POPULATIONS

3B-1: Harvest: Quantity

3B-1.a. Number of animals in reported harvest.

Sources: Arizona (1981) (1), Oregon (1982) (1), Tennessee (1982) (1), Virginia CGIF (1982) (1), O'Bara and Estes (1984) (2), Wyoming (1984) (1), Maryland (1985) (1)

Appropriateness: High

Availability: High

These data should be easily obtained if an agency requires consumptive users to report their harvest. Thus, this indicator is much more applicable to game wildlife than to fisheries management. Harvest may be categorized according to area (e.g., management district, county), program (e.g., big game), and species.

3B-1.b. Number of animals harvested per user.

Sources: Wyoming (1984) (1), Maryland (1985) (1)

Appropriateness: High

Availability: High

Data for this indicator should be available as in 3B-1.a. Harvest may be categorized as done for that indicator also.

3B-1.c. Number of pelts registered for commercial sale by furbearer harvesters.

Sources: Tennessee (1982) (1)

Appropriateness: High

Availability: High

These data should be available in agency harvest records if permittees are required to report pelt registration. Agency pelt registration program records would also contain this information. Pelts may be classified by area of harvest and species.

3B-1.d. Number of pounds commercially harvested, by type.

Sources: Oregon (1982) (1), Virginia MRC (1982) (1), Bronte and Johnson (1984) (2), Healey (1984) (3), O'Bara and Estes (1984) (3), Kansas (1985) (1), USDC (1985a) (1), USDC (1985b) (1)

Appropriateness: High

Availability: High

Permitting processes for commercial harvesters usually require catch records to be kept and reported. Data for this indicator should therefore be available in permit records. Harvest may be classified according to area or species.

3B-1.e. Number of individuals commercially harvested, by type.

Sources: Oregon (1982) (1), Kansas (1985) (1), USDC (1985b)
(1)

Appropriateness: High

Availability: Moderate

3B-1.f. National rank in total weight of commercial fish harvests.

Sources: Tennessee (1982) (1), Virginia MRC (1982) (1)

Appropriateness: High

Availability: Moderate

3B-1.g. Actual harvest as percent of available or allowable harvest.

Sources: Idaho (1978) (1)

Appropriateness: High

Availability: Moderate

3B-1.h. Percent of total national waterfowl flyway harvest taken in state.

Sources: Tennessee (1982) (1)

Appropriateness: High

Availability: Moderate

3B-1.i. Number of fish caught on charter boats during marine recreational fishing activities.

Sources: Brusher et al. (1984) (3)

Appropriateness: High

Availability: Moderate

3B-1.j. Number of fish harvested in fishing tournaments.

Sources: Willis and Gabelhouse (1983) (2)

Appropriateness: High

Availability: Moderate

3B-1.k. Number of pounds (kg) harvested recreationally, by species.

Sources: Missouri (1982) (1), Healey (1984) (2), USDC (1985c)

(1)

Appropriateness: High

Availability: Low

3B-2: Harvest: Type

3B-2.a. Percent of total harvest (number of individuals) contributed by each species or program.

Sources: Oregon (1982) (1), Virginia MRC (1982) (1), USDC (1985c) (1)

Appropriateness: High

Availability: High

In states where harvest is reported as a requirement of the licensing process, these data should be readily obtainable. Type of harvest may be characterized by species harvested or program (e. g. , big game, waterfowl).

3B-2.b. Number of new record fish and wildlife reported harvested.

Sources: Arizona (1981) (1), Virginia MRC (1982) (1)

Appropriateness: High

Availability: High

Agency records should contain this information as it is the agency that must certify each new record. Harvest records may be characterized by species, harvest location, or program.

3B-2.c. Number of trophy animals harvested.

Sources: Bennett et al. (1978) (3)

Appropriateness: High

Availability: Moderate

3B-2.d. Number of stocked animals which were harvested.

Sources: Idaho (1978) (1)

Appropriateness: High

Availability: Low

3B-2.e. Percent of animals stocked which are harvested.

Sources: Idaho (1978) (1), Tennessee (1982) (1)

Appropriateness: High

Availability: Low

3B-2.f. Ratio of female to male adults in harvest, by species.

Sources: Dickinson (1982) (2)

Appropriateness: Moderate

Availability: Low

3B-3: Populations: Quantity

3B-3.a. Percent of managed species in state that exhibit an increasing, a decreasing, or a stable trend.

Sources: Arizona (1978) (1), Conservation Foundation (1984b)
(2)

Appropriateness: High

Availability: Moderate

Agencies differ in the techniques used to evaluate population abundances. They also differ in the choice of species monitored each year. This indicator allows some comparison among states since it is not technique- or species-specific. Agencies commonly evaluate population abundances with a variety of techniques (see Davis and Winstead (1980)). Species of interest to an agency may not be monitored every year, but this indicator does not call for such intensive monitoring. A series of population estimates is required, but may be completed over a sequence of years, not necessarily every year. This indicator may be refined by categorizing species according to program. For example, if all species in the big game program are on the increase, but all species in the nongame program are on the

decrease, a re-evaluation of management objectives and practices may be in order.

3B-3.b. Percent of population change determined by direct counts for each species of interest.

Sources: Rau and Wooten (1980) (3), Arizona (1981) (1), Council on Environmental Quality (1982) (3), Oregon (1982) (1), Tennessee (1982) (1), Tautin et al. (1983) (2), Ferner (1984) (2), Florida (1984) (1), Gall and Christian (1984) (2), O'Bara and Estes (1984) (2), Maryland (1985) (1), Montalbano et al. (1985) (2)

Appropriateness: High

Availability: Low

The availability of these data will vary by state, by species, and by year. Direct count techniques are explained and compared with other techniques in Davis and Winstead (1980). Direct count data for birds may be available from a number of sources including: Office of Migratory Bird Management, U.S. Fish and Wildlife Service (North American Breeding Bird Survey, Winter Bird Survey); Colonial Bird Register, Cornell University; and Audubon Christmas Bird Count as published in "American Birds". Direct count data for other taxonomic groups may not be as readily available, and may require field surveys. Choice of species for this indicator may be based on popularity with recreationists (e.g., heavily harvested, easily observed), ec-

ological relationships (e.g., top predator, major forage base), or suspected status (e.g., possibly endangered). Direct counts may be conducted at specified times of the year (e.g., post-harvest), or in specific areas (e.g., feeding grounds, anadromous fish passages).

3B-3.c. Percent of population change determined by harvest or catch per unit effort estimates for each species of interest.

Sources: Bisselle et al. (1971) (3), Anderson (1976) (2), Bennett et al. (1978) (3), Missouri (1982) (1), Oregon (1982) (1), Gill et al. (1983) (2), Salwasser et al. (1983) (3), Willis and Gabelhouse (1983) (2), Brusher et al. (1984) (2), Florida (1984) (1), Gabelhouse (1984) (3), O'Bara and Estes (1984) (2), Wyoming (1984) (1), Montalbano et al. (1985) (3), Maryland (1985) (1)

Appropriateness: High

Availability: Low

Availability of these data will vary by state, species, and year. Species of interest may be determined by popularity with users, ecological role, or suspected status as in 3B-3.b. The total number of animals harvested per unit effort may be the parameter of interest, or specific categories may be defined (e.g., quality size fish caught per unit effort, males harvested per unit effort). Effort may refer to recreational or commercial harvest effort, or to planned sampling by agency

biologists. For example, Missouri measures the catch of stock size (>8 in) (203 mm) bass per hour of electrofishing conducted by biologists on selected waters. This indicator may be used as a statewide average, where data from all regions are pooled. Alternatively, a subset of areas which will be monitored each year may be selected as representative of the entire state or particular regions within the state.

3B-3.d. Percent of population change determined by population indices for each species of interest.

Sources: Idaho (1978) (1), Rau and Wooten (1980) (3), O'Bara and Estes (1984) (2), Montalbano et al. (1985) (3)

Appropriateness: High

Availability: Low

Species of interest may be selected according to popularity, ecological function, or suspected status as explained in 3B-3.b. Population indices are described and compared within other abundance estimation techniques in Davis and Winstead (1980). Population indices include such methods as counts of animal scats, tracks, or other signs. Indices are used primarily in situations where an object other than the animal is easier to count, but is related in some way to the number of animals present. Field surveys would be required for this indicator, but may be a part of routinely collected data in some agencies. This indicator does not measure actual population

sizes, but rather relative trends among species. Percent change may be measured according to the time frame for which data are available (e.g., percent change in 2 years).

3B-3.e. Average standing crop of selected species or taxonomic groups (e.g., pounds (kg) per acre (ha) of fish in state reservoirs).

Sources: Rau and Wooten (1980) (3), O'Bara and Estes (1984) (2), Kansas (1985) (1)

Appropriateness: High

Availability: Low

3B-3.f. Number of animals killed on highways, by species.

Sources: McCaffery (1973) (2), Wyoming (1984) (1)

Appropriateness: Moderate

Availability: Low

3B-4: Research Results: Populations

3B-4.a. Number of species management plans updated.

Sources: Arizona (1981) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

These data should be available in agency records. Population research projects may produce information useful to revising

or writing management plans for a species. The number of plans updated may be categorized according to program (e.g., big game) or taxonomic groups (e.g., fishes).

3B-4.b. Number of studies which resulted in implemented management recommendations.

Sources: Arizona (1981) (1), Oregon (1982) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: Moderate

Obtaining this information would require a review of study results and recommendations, which should be in agency files, and comparison of those with management actions. Recommendations implemented may be classified according to species, program, or taxonomic groups.

3B-4.c. Percent of managed species with sufficient information known about their requirements and population characteristics to set management objectives and regulations.

Sources: Idaho (1978) (1), Florida (1984) (1)

Appropriateness: High

Availability: Moderate

3B-5: Populations: Type

3B-5.a. Number of species for which management plans exist.

Sources: Oregon (1982) (1), Florida (1984) (1), Maryland (1985) (1)

Appropriateness: High

Availability: High

Agency activity records should contain this information. Species may also be grouped according to taxonomic classification or management program. Number of species within each of these groups may be measured.

3B-5.b. Relative ranks of all managed species in terms of use by the public.

Sources: Shaw and Mangun (1984) (3)

Appropriateness: High

Availability: Low

Actual use as a management output may be measured in terms of user numbers, recreation days, or harvest (see section 3A and other indicators in section 3B). All species may be ranked, or species may be grouped according to management program, then ranked.

4B: POPULATIONS-IMPACTS

4B-1: Damage/Depredation

4B-1.a. Number of wildlife damage complaints received.

Sources: McKegg (1984) (2)

Appropriateness: High

Availability: High

These data should be available in agency records or from cooperating organizations (e.g., state extension agents). Complaints may be classified according to type or species.

4B-1.b. Financial effects of damage by wildlife.

Sources: Dorrance (1983) (3)

Appropriateness: High

Availability: Low

A survey would be necessary to obtain these data. Financial effects may be direct (e.g., livestock killed) or indirect (e.g., higher consumer prices due to reduced supplies of agricultural products). Depredations may be classified according to species of wildlife or type of damage.

4B-2: Threatened/Endangered Species

4B-2.a. Number of species designated as endangered, threatened, or of special concern.

Sources: Jenkins (1972) (3), Council on Environmental Quality (1982) (2), Tennessee (1982) (1), Conservation Foundation (1984b) (2), Florida (1984) (1)

Appropriateness: High

Availability: High

These data should be available in agency records, from the National Heritage Program of the Nature Conservancy, from the U.S. Fish and Wildlife Service Office of Endangered Species, or from the U.S.D.O.E. U.S. Endangered Species Distribution File. States with computerized information systems should find these data highly available. Species may be classified according to type of listing (e.g., state, federal) or by taxonomic group (e.g., vertebrates).

4B-2.b. Number of recovery increments achieved.

Sources: USFS (1984) (1)

Appropriateness: High

Availability: Low

Field surveys would be necessary to obtain these data. Recovery increments, as used by the Forest Service, differ according to

species and program. Recovery increments include such measures as number of individuals, number of breeding pairs, and miles or acres of habitat occupied.

4B-2.c. Percent of listed species in state with completed recovery plans.

Sources: Arizona (1981) (1), Tennessee (1982) (1), Michigan (1984) (1), Conservation Foundation (1984b) (2)

Appropriateness: High

Availability: High

These data should be available in state agency records or from the U.S. Fish and Wildlife Service, Office of Endangered Species.

4B-2.d. Number of areas in state with re-established populations.

Sources: Arizona (1981) (1)

Appropriateness: Moderate

Availability: Moderate

4B-3: Resource Utilization

4B-3.a. Number of harvest permits authorized, where permits are limited.

Sources: Arizona (1981) (1)

Appropriateness: High

Availability: High

Agency records should contain this information. In states where harvest permits are limited, a decline in number of permits issued reflects a decline in number of animals or habitat occupied.

4B-3.b. Catch per unit effort (CPUE) for selected species compared to national average.

Sources: Florida (1984) (1)

Appropriateness: High

Availability: Low

Marine fisheries data may be available from the National Marine Fisheries Service. Surveys would be necessary for the majority of freshwater and recreational harvests.

4B-3.c. Ratio of actual harvest to estimated maximum sustained yield for selected species.

Sources: Bisselle et al. (1971) (3)

Appropriateness: High

Availability: Low

4B-3.d. Exploitation status of harvested species measured as the catch per unit effort ratio: CPUE (current)/CPUE (5 yr. average).

Sources: Bisselle et al. (1971) (3)

Appropriateness: Moderate

Availability: Low

4B-3.e. Percent of successful harvesters for selected species.

Sources: Idaho (1978) (1), Arizona (1981) (1), Oregon (1982) (1), Wyoming (1984) (1)

Appropriateness: Moderate

Availability: Low

4B-4: Effects on Unmanaged Species

4B-4.a. Percent of unmanaged species in state exhibiting an increasing trend, a decreasing trend, or a stable trend.

Sources: Conservation Foundation (1984b) (3)

Appropriateness: High

Availability: Low

Data on unmanaged species are usually hard to obtain since no field surveys or monitoring activities are directed toward them. New data collection methods would be necessary.

4B-4.b. Number of native species displaced or enhanced due to management for game species.

Sources: B. Knuth (4)

Appropriateness: High

Availability: Low

Field surveys would be required to obtain this information.

4B-5: Wildlife Hazards

4B-5.a. Number of incidents reported between birds and aircraft.

Sources: Gabbita et al. (1984) (3)

Appropriateness: High

Availability: High

These data should be available in agency or airport records. Incidents may be classified by species involved or type of incident (e.g., aircraft damaged by bird strikes, aircraft crashes, delayed flights).

4B-5.b. Number of human maulings or deaths by wildlife reported.

Sources: B. Knuth (4)

Appropriateness: High

Availability: High

These data should be available in agency records. Maulings occur where animals are habituated to human presence, attracted in some way, or provoked by humans.

4B-5.c. Number of reported incidents of wildlife-related communicable diseases.

Sources: B. Knuth (4)

Appropriateness: High

Availability: High

State health department records should have these data available. Information may be categorized according to species involved, type of disease, and region of state.

1C: INPUTS-HABITAT

1C-1: Holdings: Land

1C-1.a. Number of acres (ha) of lands under agency management.

Sources: Idaho (1978) (1), Oregon (1982) (1), Virginia MRC (1982) (1)

Appropriateness: High

Availability: High

These data should be readily available in agency management or landholding records. The most definite "input" to habitat management and availability are those lands an agency has under its control. Lands directly under agency management, owned by the agency or not, are much more likely to be managed as wildlife habitat than other lands.

1C-1.b. Number of acres (ha) of potential wildlife habitat in each ownership type.

Sources: Epperson (1980) (2)

Appropriateness: High

Availability: Moderate

Potential wildlife habitat refers to lands which are capable of supporting wildlife as one of their main products. For ex-

ample, municipal parks are potential habitat, but urban residential areas and industrial sites are not. Ownership type may be categorized by federal, state, county, municipal, private, and private-for-profit ownership. Data for this indicator should be available in agency land records and the records of the relevant state real-estate/land ownership office. Federal land ownership data may be available from the following: USDA Forest Service, Land Areas of the National Forest System data base; USDI Annual Report of Lands Under Control of the U.S. Fish and Wildlife Service; USDA Economic Research Service Land Ownership Survey. Field verification may be necessary where land uses are not specified on ownership records. The indicator may be further refined by classifying land by habitat type (e.g., wetlands, woodlands, agriculture).

1C-1.c. Ratio of public to private habitat ownership (acres or ha).

Sources: Snepenger and Ditton (1985) (2)

Appropriateness: High

Availability: Moderate

1C-2: Holdings: Water

1C-2.a. Number of surface acres (ha) and/or stream miles (km) under agency management.

Sources: Idaho (1978) (1), Oregon (1982) (1), Tennessee (1982) (1), Virginia MRC (1982) (1), Florida (1984) (1), Kansas (1985) (1)

Appropriateness: High

Availability: High

Agency records should contain information regarding this indicator. As with 1C-1.a, waters managed directly by an agency are those most likely to be suitable for producing those benefits in which an agency is interested.

1C-2.b. Number of surface acres (ha) and/or stream miles (km) in each ownership type.

Sources: Epperson (1980) (2)

Appropriateness: High

Availability: Moderate

Data for this indicator are likely available in agency management records and records of other state agencies involved with land or water ownership. Ownership types may be categorized as federal, state, county, municipal, private, and private-for-profit. The indicator may be refined to include classifications by habitat type (e.g., stream order, ponds, reservoirs). Field verification may be necessary where specific habitat types are not stated in ownership records.

1C-2.c. Number of units in each habitat type, by type of ownership.

Sources: Epperson (1980) (2)

Appropriateness: High

Availability: Moderate

1C-3: Water Quality

1C-3.a. Number of water pollution episode days reported per year.

Sources: Bisselle et al. (1971) (3)

Appropriateness: High

Availability: High

Water quality data are routinely collected by the Office of Water and Hazardous Materials of the U.S. Environmental Protection Agency. The U.S. EPA Clearinghouse on EPA Data Bases and the Storage and Retrieval of Parametric Water Quality Data (STORET) computerized data system include state-level water quality information. While "reported" days of pollution do not always equal the actual days of pollution, this measure allows a consistent assessment of state-wide water quality over time.

1C-3.b. Percent of water bodies in state meeting water quality standards.

Sources: Bisselle et al. (1971) (3)

Appropriateness: High

Availability: Moderate

Water quality standards are established by the U.S. Environmental Protection Agency. Reported violations of standards would be available from the water office listed in 1C-3a. Information on water bodies in the state may be available from state environmental quality office records, the Water Data Storage and Retrieval System (WATSTORE) of the U.S. Geological Survey, or may be gathered as a component of standard agency fisheries habitat surveys. These data may be compared with federal water quality standards to determine the percent of water bodies in compliance with the standards. Water quality varies over time, so this indicator may refer to a specific point in time or to an annual measure (e.g., percent waters which met water quality standards during the entire year).

1C-3.c. Annual median concentrations of selected pollutants in a sample of state waters (fecal coliform bacteria, total phosphorous, dissolved oxygen, total cadmium, total lead, total mercury).

Sources: Council on Environmental Quality (1980) (2)

Appropriateness: High

Availability: Moderate

1C-3.d. Percent of state waters receiving excess sediment.

Sources: Tennessee (1982) (1), Hill (1984) (2)

Appropriateness: High

Availability: Low

1C-3.e. Percent of waters with water quality problems caused by each source type (e.g., nonpoint, point, agricultural, urban).

Sources: Judy et al. (1984) (3)

Appropriateness: High

Availability: Low

1C-3.f. Percent of water with water quality adversely affecting the fish community.

Sources: Judy et al. (1984) (3)

Appropriateness: High

Availability: Low

1C-3.g. Percent of water bodies with no fish life.

Sources: Judy et al. (1984) (3)

Appropriateness: High

Availability: Low

1C-3.h. Average annual soil erosion rate (tons/acre or kg/ha).

Sources: Council on Environmental Quality (1980) (2)

Appropriateness: Moderate

Availability: Low

1C-4: Air Quality

1C-4.a. Number of air pollution episode days reported per year.

Sources: Rau and Wooten (1980) (3)

Appropriateness: High

Availability: High

Air quality data are routinely collected by the federal Environmental Protection Agency (Clearinghouse on EPA Data Bases, Storage and Retrieval of Aerometric Data), and also by state environmental quality offices. Pollutants of interest may include sulfur oxides, nitrogen oxides, particulates, carbon monoxide, ozone, hydrocarbons, and lead.

1C-4.b. Percent of monitors in state receiving rain of less than 5.6 pH.

Sources: Council on Environmental Quality (1982) (2)

Appropriateness: High

Availability: High

Both federal and state environmental quality offices monitor rainfall pH. Number of monitors varies among states. "Natural" rain has a pH of 5.6. Values below this standard indicate a greater than natural amount of acidity in rainfall. Acidic precipitation affects terrestrial and aquatic habitats.

1C-4.c. Number of counties in nonattainment with federal air quality standards.

Sources: Council on Environmental Quality (1982) (2)

Appropriateness: High

Availability: Moderate

1C-4.d. Annual mean concentrations of selected air pollutants, by type of area (e.g., urban, industrial, rural).

Sources: Council on Environmental Quality (1980) (2)

Appropriateness: High

Availability: Moderate

1C-4.e. Percent of year selected areas were within each U.S. EPA "Pollution Standards Index" categories.

Sources: Council on Environmental Quality (1982) (2)

Appropriateness: High

Availability: Moderate

2C: PROCESSES-HABITAT

2C-1: Habitat Acquisitions

2C-1.a. Number of sites investigated for potential acquisition.

Sources: Missouri (1982) (1)

Appropriateness: High

Availability: High

Agency activity records should contain this information. This indicator may be used in conjunction with other indicators in this section to compare investigated sites with those actually acquired.

2C-1.b. Number of acres (ha) approved for agency lease and/or purchase.

Sources: USFWS (1980) (1)

Appropriateness: High

Availability: High

This information should be available in agency records. This indicator may be used with other indicators in this section to compare sites investigated with those approved for purchase, and lands approved with areas actually acquired.

2C-1.c. Number of acres (ha) acquired and/or leased for fisheries and wildlife resource use.

Sources: USFWS (1980) (1), Missouri (1982) (1), Oregon (1982) (1), Virginia CGIF (1982) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

Acres acquired or leased may be categorized according to habitat type (e.g., wetlands) or use type (e.g., fishing lake).

This information should be available in agency records.

2C-2: Research: Habitat

2C-2.a. Amount of money committed to research addressing habitat.

Sources: National Science Board (1981) (2), Miller et al. (1983) (2), Weber and Horak (1983) (2)

Appropriateness: High

Availability: High

Agency fiscal records should contain this information. This indicator may be compared with other indicators in sections 2A-7 and 2B-1 to assess the relative research emphasis on habitat concerns.

2C-2.b. Percent of personnel time spent on habitat research.

Sources: Arizona (1981) (1), Weber and Horak (1983) (2)

Appropriateness: High

Availability: High

This information should be available in employee activity reports. This indicator may be used to compare the importance of habitat research with other activities based on staff time.

2C-2.c. Number of research studies addressing fish and wildlife habitat.

Sources: Wyoming (1984) (1)

Appropriateness: Moderate

Availability: High

2C-2.d. Number of personnel assigned to habitat research projects.

Sources: Arizona (1981) (1)

Appropriateness: Moderate

Availability: High

2C-3: Habitat Manipulation

2C-3.a. Number of habitat improvement structures provided.

Sources: Oregon (1982) (1), Virginia MRC (1982) (1), Teer et al. (1983) (2), USFS (1984) (1)

Appropriateness: High

Availability: High

Habitat improvement structures may be categorized by program (e.g., stream game fish, waterfowl) or type of structure. Improvements include such things as nesting structures, fishways, water developments, and cover. Area of placement may also be specified according to public or private lands, or management districts on public lands. Information for this indicator should be available in personnel activity reports.

2C-3.b. Number of acres (ha) of habitat treated with improvement practices.

Sources: Oregon (1982) (1), Virginia CGIF (1982) (1), Nelson et al. (1983) (2), USFS (1984) (1)

Appropriateness: High

Availability: High

Improvement practices include such activities as seeding and planting, release burnings, aquatic plant control, stream barrier removal, and habitat fertilization. Improvements may be classified according to program, management area, or land ownership type as in 2C-3.a. Agency activity reports should contain this information.

2C-3.c. Percent of personnel time devoted to habitat management activities.

Sources: Arizona (1981) (1)

Appropriateness: High

Availability: High

This information should be available in personnel activity reports. Habitat management may be categorized according to type of program or type of activity.

2C-3.d. Cost of habitat improvement activities.

Sources: USFWS (1980) (1), Teer et al. (1983) (2)

Appropriateness: High

Availability: Moderate

2C-4: Habitat Conversion

2C-4.a. Number of proposed land and water development permits reviewed.

Sources: Arizona (1981) (1), Lindall and Thayer (1982) (2)

Appropriateness: High

Availability: High

Permit review processes are often a function of state fisheries and wildlife agencies. Development permit requests are an indication of the demand for habitat conversion activities. Agency activity reports should contain information on the num-

ber of permits reviewed. Permits may be classified according to the type of habitat conversion concerned (e.g., wetland drainage, stream channelization, creation of impoundments).

2C-4.b. Number of acres (ha) of habitat proposed for conversion in land and water development permits.

Sources: Lindall and Thayer (1982) (2)

Appropriateness: High

Availability: High

Permits should specify the number of affected acres from each project. Permits may be classified as to type of habitat, as in 2C-4.a. Agency permit records should contain this information.

2C-4.c. Number of acres (ha) of habitat approved for conversion in permit review process.

Sources: Lindall and Thayer (1982) (2)

Appropriateness: High

Availability: High

Agency permit review records should contain this information. Permit approvals may be classified according to habitat type, as in 2C-4.a.

2C-4.d. Percent of personnel time devoted to permit review activities.

Sources: Arizona (1981) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

This information should be available in personnel activity reports. Comparing this indicator with similar indicators will allow an assessment of the relative emphasis placed on various personnel activities.

2C-4.e. Number of acres of habitat converted each year.

Sources: Tennessee (1982) (1), Conservation Foundation (1984b) (2), Kansas (1985) (1), Maryland (1985) (1)

Appropriateness: High

Availability: Low

2C-5: Pollution

2C-5.a. Number of pollution-related investigations conducted.

Sources: Arizona (1981) (1), Missouri (1982) (1)

Appropriateness: High

Availability: High

Agency activity reports should contain this information. Investigations may be categorized according to type or source of pollution (e.g., toxic spill, sewage).

2C-5.b. Number of fishing bans and/or health alerts issued.

Sources: Council on Environmental Quality (1982) (2)

Appropriateness: High

Availability: High

Fishing bans are orders to prohibit fishing in certain waters. Health alerts are warnings regarding the consumption of fish or game flesh due to contamination with toxic substances. This information should be contained in agency records. This indicator may be further refined by specifying the pollutant involved.

2C-5.c. Number of fishing areas closed to commercial operators.

Sources: Council on Environmental Quality (1982) (2)

Appropriateness: High

Availability: High

This information should be available in agency records. Area closure is a common practice in shellfish areas when water quality does not meet health standards.

2C-5.d. Number of shoreline miles (km) or fishing acres (ha) declared closed to fishing during year.

Sources: Bisselle et al. (1971) (3)

Appropriateness: High

Availability: High

This information should be available from the same sources as in 2C-5.c. Reason for closure may be specified.

2C-5.e. Percent of shellfish areas which were closed to commercial harvest at any time during year.

Sources: Council on Environmental Quality (1982) (2)

Appropriateness: High

Availability: Moderate

2C-5.f. Percent of watersheds which were under a fish advisory or ban during year.

Sources: Council on Environmental Quality (1982) (2)

Appropriateness: High

Availability: Moderate

2C-5.g. Number of beach closings in state due to pollution.

Sources: Council on Environmental Quality (1980) (2)

Appropriateness: Moderate

Availability: High

3C: OUTPUTS-HABITAT

3C-1: Habitat: Quantity

3C-1.a. Number of acres (ha) certified in backyard habitat certification program (e.g., by National Wildlife Federation).

Sources: Gray and Larson (1982) (3)

Appropriateness: High

Availability: High

Data for this indicator should be available from the certification organization. This measure indicates the quantity of habitat provided in residential areas.

3C-1.b. Number of acres (ha) in state in each land use/land cover type.

Sources: Whitaker and McCuen (1976) (3), Idaho (1978) (1), Council on Environmental Quality (1982) (2), Tennessee (1982) (1), Hoekstra et al. (1983) (3), O'Bara and Estes (1984) (2), Tiner (1984) (2), Wyoming (1984) (1), Kansas (1985) (1)

Appropriateness: High

Availability: Moderate

Land use or land cover type may be specified as agriculture, forestry, riparian, riverine, wetlands, residential, etc.

Sources for these data, on possible land cover classifications, include state land records as well as the following federal sources: USDA, Forest Service Resource Inventory, Soil Conservation Service National Resource Inventory, Forest Service Forest Size Class System, Forest Service Forest Cover Type System; Economic Research Service County Estimates File; USDC, Bureau of the Census Census of Agriculture; USDOE, Geocology Data Base at Oak Ridge National Laboratory; USDI Fish and Wildlife Service National Wetlands Inventory, Geological Survey Land Use and Land Cover System. These federal sources may not have data for an entire state, but may yield useful information on specific areas within a state.

3C-1.c. Percent of state in each land use/land cover type.

Sources: Hoekstra et al. (1983) (3), Tiner (1984) (2)

Appropriateness: High

Availability: Moderate

Data sources are listed in 3C-1.a, with examples for potential cover type and use type classifications.

3C-1.d. Number of acres (ha) in each ownership type (e.g., residential, agricultural, state, federal) specifically managed for wildlife.

Sources: USFWS (1980) (1), Teer et al. (1983) (2)

Appropriateness: High

Availability: Low

3C-1.e. Percent of land in each ownership type specifically managed for wildlife.

Sources: Michigan (1984) (1)

Appropriateness: High

Availability: Low

This measure indicates groups of landowners which may benefit from personal contacts or educational programs targeted at increasing their management emphasis on wildlife. It may signal to the agency a need for incentive programs directed at particular groups.

3C-1.f. Percent of land classified by vegetation structure and productivity.

Sources: Hoekstra et al. (1983) (3)

Appropriateness: High

Availability: Low

3C-2: Research Results: Habitat

3C-2.a. Number of habitat management plans updated.

Sources: Wyoming (1984) (1)

Appropriateness: High

Availability: High

Agency records should contain these data. Habitat research projects may produce information useful to revising or writing habitat management plans. Management plans may be categorized according to area of state or type of habitat.

3C-2.b. Number of studies which resulted in implemented management recommendations.

Sources: Wyoming (1984) (1)

Appropriateness: High

Availability: Moderate

Agency records should contain information on completed studies and recommendations made. These may be compared with actual management actions to obtain information on this indicator. Habitat recommendations may be categorized according to area of state or type of habitat.

3C-2.c. Percent of species in state for which habitat suitability index has been developed.

Sources: Michigan (1984) (1)

Appropriateness: High

Availability: Low

3C-2.d. Percent of state in which habitat type has been mapped.

Sources: Tiner (1984) (2)

Appropriateness: High

Availability: Low

Knowledge of habitats available in a state is critical for developing management plans realistically. Data for this indicator may be available from agency records or from state land maps.

3C-3: Habitat Types

3C-3.a. Number of habitat types occurring in state.

Sources: Marshall (1985) (3), Rafe et al. (1985) (3)

Appropriateness: High

Availability: High

Variety of habitat types is an important influence on species occurrence. This indicator is a simple measure of that characteristic. Data are potentially available in state land records and for certain areas, in the Natural Heritage Data Bank of the Nature Conservancy.

3C-3.b. Number of state-owned wildlife areas managed specifically for each type of wildlife.

Sources: USFWS (1980) (1)

Appropriateness: High

Availability: High

Type of wildlife may be categorized by species, program, or taxonomic group. Habitat management practices will vary depending on the type of wildlife of interest. These data should be available in agency records.

3C-3.c. Percent of recreationist use (e.g., visits, user-days) received by each habitat type.

Sources: Shaw and Mangun (1984) (3)

Appropriateness: Moderate

Availability: Low

3C-4: Reserves: Quantity

3C-4.a. Number of land reserves or protected areas in state.

Sources: Burns (1983) (2), Blake and Karr (1984) (2)

Appropriateness: High

Availability: High

Possible data sources for this indicator include state land records, the National Heritage Data Bank of the Nature Conservancy, and the Smithsonian Natural Areas Institute's computerized inventory of private and public natural and protected areas. Reserves may be categorized according to ownership, habitat type, or target species.

3C-4.b. Number of natural areas or reserves designated by the state.

Sources: Missouri (1982) (1)

Appropriateness: High

Availability: High

Agency records or state land records should contain this information. Reserves may be categorized according to habitat type or target species.

3C-4.c. Number of acres (ha) designated as natural areas or reserves.

Sources: Missouri (1982) (1)

Appropriateness: High

Availability: High

This information should be available in agency records. Reserves may be categorized according to habitat type or target species.

3C-4.d. Percent of total area in state devoted to reserves.

Sources: Gengtao (1985) (3)

Appropriateness: High

Availability: High

This information should be available in agency records or land records described in 3C-4. a, compared with total land in state.

Reserves may be categorized according to habitat type or target species.

3C-4.e. Ratio of areas within legal reserve boundaries to areas within biotic reserve boundaries (in square miles) (km²), where biotic reserve areas are those which would be necessary to maintain existing ecological processes and a given assemblage of species within a reserve.

Sources: Newmark (1985) (3)

Appropriateness: High

Availability: Low

3C-5: Reserves: Type

3C-5.a. Mean size of reserves.

Sources: Blake and Karr (1984) (2)

Appropriateness: High

Availability: High

State land records or other sources listed in 3C-4 may have this information available. Reserves may be categorized according to habitat type, target species, or ownership.

3C-5.b. Number of habitat or ecosystem types represented in reserves.

Sources: Jenkins (1972) (3)

Appropriateness: High

Availability: Moderate

State land records and other sources listed in 3C-4 may contain this information. A listing of habitat types would be available as a result of gathering information for 3C-3. a.

3C-5.c. Percent of species in state represented in reserves.

Sources: Blake and Karr (1985) (2)

Appropriateness: High

Availability: Low

State species lists, compared with field survey data of reserves, should yield this information. This measure may highlight the need for more, different reserves if a low percent of state species is currently represented in reserves.

3C-6: Habitat Quality

3C-6.a. Degree of interspersion of land uses/cover types.

Sources: Whitaker and McCuen (1976) (3)

Appropriateness: High

Availability: Low

The method for calculating degree of interspersion based on average distances between different land uses is explained in

Whitaker and McCuen (1976). Some of these data will be available from indicators in 3C-3, but further analysis, interpretation, and possibly survey work would be necessary. Desired amounts of habitat interspersion will differ depending on the desired species of wildlife and the desired mix of generalist and specialist species.

3C-6.b. For a given species or species group, percent of habitat in state suitable to support the species.

Sources: Vaughan and Russell (1981) (2), Everest and Summers (1982) (3), Taylor and King (1983) (3), Kroodsma (1985) (2)

Appropriateness: High

Availability: Low

Information for this indicator may be gathered using indicators from 3C-1 and knowledge of a species and its habitat requirements. Field verification may be necessary to document the suitability of a particular area to meet a species' requirements.

3C-6.c. Percent of farm acreage (ha) in state on which habitat conservation measures are practiced.

Sources: O'Bara and Estes (1984) (2), Urich et al. (1984) (2), Langner (1985) (2)

Appropriateness: High

Availability: Low

3C-6.d. Percent of stream reaches in state experiencing less than minimum instream flows at any time of the year.

Sources: Winters (1983) (2), Judy et al. (1984) (3)

Appropriateness: High

Availability: Low

3C-6.e. Number of miles (km) of road per square mile of wildlife habitat.

Sources: Thiel (1985) (2)

Appropriateness: High

Availability: Low

4C: IMPACTS-HABITAT

4C-1: Preservation

4C-1.a. Number of acres (ha) for which agency recommends proposed land and water development permits be denied.

Sources: Lindall and Thayer (1982) (2)

Appropriateness: High

Availability: High

This information should be recorded as part of the permit review process. Type of habitat concerned and reason for denial may be specified. This measure, used in conjunction with 2C-4.b, the number of acres proposed for conversion, indicates the amount of habitat an agency suggests, through the environmental review process, not be converted to a different use.

4C-1.b. Number of acres (ha) acquired for mitigation purposes.

Sources: Lindall and Thayer (1982) (2), Wyoming (1984) (1)

Appropriateness: High

Availability: High

Agency records should contain this information. Development permits often require an equivalent amount of mitigation lands

to be set aside to offset the loss of lands to development activities.

4C-1.c. Number of critical areas designated for threatened and endangered species.

Sources: Council on Environmental Quality (1982) (2)

Appropriateness: High

Availability: High

These data should be available in agency records, from the U. S. Fish and Wildlife Service Office of Endangered Species, or from the U. S. Endangered Species Distribution File of the U. S. DOE. Critical habitats are those areas on which threatened and endangered species depend for survival.

4C-1.d. Percent of state land contained in state and national parks and wildlife preserves.

Sources: Conservation Foundation (1984a) (2)

Appropriateness: High

Availability: High

Data may be available from a comparison of state land ownership records with land maps. This measure indicates the amount of land in the state on which development may not occur.

4C-1.e. Number of threatened or endangered species found on preserves in state.

Sources: Hoose (1983) (2)

Appropriateness: High

Availability: Moderate

4C-1.f. Percent of state land in protected areas (e.g., parks, preserves) compared to national average.

Sources: Conservation Foundation (1984a) (2)

Appropriateness: High

Availability: Moderate

4C-1.g. Percent of development permits reviewed for which agency recommendations on habitat concerns were incorporated.

Sources: Lindall and Thayer (1982) (2)

Appropriateness: High

Availability: Low

Field surveys would be necessary to collect these data. This measure indicates the actual influence an agency has in preserving the suitability of lands for use by fish and wildlife.

4C-2: Ecosystem Values

4C-2.a. Species diversity in selected communities or areas.

Sources: Rau and Wooten (1980) (3), Noss (1983) (3), Florida (1984) (1), Healey (1984) (3), Pearsall (1984) (3)

Appropriateness: High

Availability: Low

Field surveys would be necessary to collect this information. Specific areas should be selected for regular monitoring so changes within an area from year to year may be detected. Areas may be selected on the basis of habitat type or locality.

4C-2.b. Percent of habitat or ecosystem types represented in reserved areas.

Sources: Blake and Karr (1985) (2)

Appropriateness: High

Availability: Low

These data may be available from state land records or agency habitat surveys. The National Natural Landmarks Program of the U.S. Department of Interior may be a useful source for identifying ecological types and present status of certain areas. If ecosystems are protected as preserved lands, they are more likely to remain functioning systems than if they are fragmented or converted to other uses.

4C-3: Scientific Studies

4C-3.a. Number of reserve areas designated as research natural areas.

Sources: Jenkins (1972) (3)

Appropriateness: High

Availability: High

These data should be available in agency records, from the Smithsonian Natural Areas Institute in Washington, D.C., or from the Natural Heritage Program of the Nature Conservancy. These areas provide an undisturbed setting in which short- or long-term studies may be conducted.

4C-3.b. Number of people (cooperating on state research projects) who are working for advanced degrees at state educational institutions.

Sources: Arizona (1981) (1)

Appropriateness: Moderate

Availability: High

Agency records or state institutions should have this information available. Type of degree or type of project may be specified.

4C-4: Environmental Impacts

4C-4.a. Percent of state waters (number) for which fish kills were reported in a year.

Sources: Judy et al. (1984) (3)

Appropriateness: High

Availability: High

State environmental division records should contain this information. Fish kills may be classified by source type or water type.

4C-4.b. Number of fish-kill incidents reported.

Sources: Bisselle et al. (1971) (3), Arizona (1981) (1), Council on Environmental Quality (1982) (2), Oregon (1982) (1), Tennessee (1982) (1), O'Bara and Estes (1984) (3)

Appropriateness: High

Availability: High

These data should be available in environmental division records. Type of pollution or water type may be specified.

4C-4.c. Number of acres (ha) or river miles (km) reported affected in fish-kill pollution events.

Sources: Biselle et al. (1971) (3)

Appropriateness: High

Availability: High

Environmental division records should contain this information.

Type of pollution or water type may be specified.

4C-4.d. Number of fish killed in reported pollution events.

Sources: Bisselle et al. (1971) (3), Council on Environmental Quality (1981) (2), (1982) (2)

Appropriateness: High

Availability: Moderate

4C-4.e. Monetary value of fish killed in pollution events.

Sources: Oregon (1982) (1)

Appropriateness: High

Availability: Moderate

4C-4.f. Average concentrations of toxic residues in animals, by type of residue and species or taxonomic group.

Sources: Bisselle et al. (1971) (3), Council on Environmental Quality (1982) (2)

Appropriateness: High

Availability: Low

Field surveys and regular monitoring would be necessary to obtain this information. This measure is indicative of environmental contamination and its effects on fish and wildlife.

4C-4.g. Number of acres (ha) or miles (km) of habitat experiencing pollution, by type of pollution and habitat.

Sources: Council on Environmental Quality (1980) (2), Tennessee (1982) (1)

Appropriateness: High

Availability: Low

Field surveys would be necessary to obtain this information. This measure indicates how widespread environmental degradation is within a state.

4C-4.h Percent of acres (ha) lost as fisheries and wildlife habitat attributable to each development type.

Sources: Tiner (1984) (3)

Appropriateness: High

Availability: Low

4C-4.i Percent change in number of species present with change in recreation use.

Sources: Van der Zande et al. (1984) (3)

Appropriateness: High

Availability: Low

1D: INPUTS-ADMINISTRATION

1D-1: Revenue

1D-1.a. Total annual agency revenues.

Sources: Arizona (1982) (1), Virginia CGIF (1982) (1),
Virginia MRC (1982) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

Agency fiscal records are the source of data for this indicator. This measure summarizes revenues from all sources for the agency. This indicator may be used with other revenue indicators to calculate the percent of total revenues contributed by a particular source.

1D-1.b. Revenues received from user fees.

Sources: Wyoming (1984) (1), Cordell and Hartmann (1982) (2)

Appropriateness: High

Availability: High

User fees include sale of hunting and fishing licenses, tag fees, and entrance fees to management areas. This measure reflects fees assessed to and paid by the actual users of the

resource. Agency fiscal receipts should contain data for this indicator.

1D-1.c. Revenues received from tax checkoff donations.

Sources: Oregon (1982) (1), Virginia CGIF (1982) (1), Kansas (1985) (1)

Appropriateness: High

Availability: High

Agency and tax department records should have these data available. This measure reflects voluntary donations by the tax-paying public. If checkoff revenues are targeted for a particular use (e.g., endangered species), this measure reflects the population of total agency revenues received for a certain use, when applied in conjunction with 1D-1.a.

1D-1.d. Revenues received from federal aid sources.

Sources: USFWS (1980) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

These data are available in agency fiscal records. Federal aid sources include Pittman-Robertson and Wallop-Breaux (Dingell-Johnson) funds.

1D-1.e. Percent of agency revenues derived from each source.

Sources: Spencer et al. (1983) (2)

Appropriateness: High

Availability: High

Sources may include any of the above categories (e.g., tax checkoff, federal aid) and other sources of interest such as fines, timber sales, or the general fund. These data should be readily calculated from agency fiscal records.

1D-1.f. Revenues available through federal aid but which reverted to the U.S. Fish and Wildlife Service.

Sources: USFWS (1980) (1)

Appropriateness: High

Availability: High

This information should be available from the Federal Aid Office of the U.S. Fish and Wildlife Service. This measure indicates potential revenue from which the agency was not able to benefit.

1D-1.g. Ratio of change in license fees to change in consumer price index.

Sources: Anderson et al. (1985) (2)

Appropriateness: High

Availability: Moderate

1D-1.h. Net revenues from consumptive use programs (license revenues - costs of management).

Sources: Wyoming (1984) (1)

Appropriateness: Moderate

Availability: Low

1D-2: Legislation

1D-2.a. Number of pieces of legislation passed during year affecting agency activities.

Sources: Burch (1980) (2), Oregon (1982) (1), Wyoming (1984)

(1)

Appropriateness: High

Availability: High

State legislative records and agency records would contain this information. Legislation directed at agency activities serves as a guide and a constraint. Many new pieces of legislation addressing an agency may indicate problems in the past necessitating legislative review, or may indicate that an agency has become much more important in the public eye.

1D-2.b. Percent of legislative session devoted to addressing agency activities.

Sources: B. Knuth (4)

Appropriateness: High

Availability: Low

This information would be difficult to obtain but is available in legislative records and transcripts. The amount of legislators' time devoted to any problem (e.g., resource agency) is indicative of the importance which they assign to it.

1D-3: Holdings: Facilities

1D-3.a. Number of agency-owned facilities per unit land area.

Sources: Vaughan and Russell (1984) (3)

Appropriateness: High

Availability: High

Agency ownership records and state land records are the likely data sources for this indicator. Facilities may be classified by type, for example, interpretive centers, fish cleaning stations, vehicle garages, and maintenance centers.

1D-3.b. Number of agency-owned facilities per capita.

Sources: Vaughan and Russell (1984) (3)

Appropriateness: High

Availability: High

Agency ownership records and state population records are likely data sources. Facilities may be classified by type, as in 1D-3.a.

1D-3.c. Number of facilities in each ownership type (federal, state, county, municipal, private).

Sources: Epperson (1980) (2), Arizona (1981) (1)

Appropriateness: High

Availability: Moderate

1D-4: Personnel: Quantity

1D-4.a. Number of employees in agency, by type.

Sources: Arizona (1981) (1), Missouri (1982) (1), Oregon (1982) (1), Virginia CGIF (1982) (1), Virginia MRC (1982) (1), Wyoming (1984) (1), Maryland (1985) (1)

Appropriateness: High

Availability: High

Agency personnel records are the source for these data. Types of employees may be listed by employment status (e.g., full-time, seasonal) or job type (e.g., biologist, clerical, law enforcement).

1D-4.b. Number of employees in each job category per 100,000 user-days of resource recreation.

Sources: Spencer et al. (1983) (2)

Appropriateness: High

Availability: Low

The difficulty in obtaining data for this indicator is in determining the number of user-days which occur in the state (see section 3A). Employee records are available in agency personnel offices. Job categories most pertinent to this indicator include law enforcement, biologist, and information officer.

1D-5: Personnel: Qualifications

1D-5.a. Number of employees with B.S., M.S., and Ph.D. degrees (or equivalent).

Sources: Hunter (1984) (2), Sullivan and Brome (1984) (2)

Appropriateness: High

Availability: High

Agency personnel records are a likely source for this indicator. Employment categories may be used to refine the indicator. For example, the number of clerical workers with graduate degrees may not be as important as biologists or administrators with graduate degrees.

1D-5.b. Percent of employees with B.S., M.S., and Ph.D. degrees (or equivalent).

Sources: National Science Board (1981) (2), Sullivan and Brome (1984) (2)

Appropriateness: High

Availability: High

Agency personnel records should contain data for this indicator.

Specific categories may be used, as in 1D-5.a.

1D-5.c. Average number of years of experience, by job category for all personnel.

Sources: Judy et al. (1984) (3)

Appropriateness: High

Availability: High

Agency personnel records should contain data for this indicator. Job categories may include fish biologists, wildlife biologists, administrators, technicians, law enforcement officers, information specialists, and clerical workers. This indicator may be modified to the experience at the time of hiring to give an indication of personnel qualifications at the start of agency employment.

2D: PROCESSES-ADMINISTRATION

2D-1: Interagency Cooperation

2D-1.a. Number of requests received for agency technical assistance.

Sources: Arizona (1981) (1), Lindall and Thayer (1982) (2),
Decker et al. (1983) (3), Wyoming (1984) (1)

Appropriateness: High

Availability: High

This information should be available in agency records. Requests may come from agencies on any level (municipal, state, federal, private) and may be categorized according to type of assistance (e.g., permit review, field assistance).

2D-1.b. Percent of requests for technical assistance received that were met.

Sources: - Lindall and Thayer (1982) (2), Wyoming (1984) (1)

Appropriateness: High

Availability: High

Agency activity reports should contain this information. Requests may be classified as in 2D-1.a according to requesting agency or type of assistance.

2D-1.c. Number of cooperative agreements arranged.

Sources: Miller et al. (1983) (2)

Appropriateness: High

Availability: High

Cooperative agreements are formal arrangements by which one agency can receive some form of assistance from, or give assistance to, another agency. Types of assistance or characteristics of cooperative agencies may be specified. This information should be available in agency records.

2D-1.d. Number of assignments on professional and governmental committees held by agency personnel.

Sources: Arizona (1981) (1)

Appropriateness: High

Availability: Moderate

2D-1.e. Number of other states with which an agency regularly exchanges research results and harvest information.

Sources: Michigan (1984) (1)

Appropriateness: Moderate

Availability: Moderate

2D-2: Planning

2D-2.a. Number of strategic plans completed.

Sources: Arizona (1981) (1)

Appropriateness: High

Availability: High

This information should be available in agency records. Plans may be categorized according to program (e. g. , big game, stream fisheries).

2D-2.b. Percent of personnel time spent on planning activities.

Sources: Arizona (1981) (1)

Appropriateness: High

Availability: High

Personnel activity reports should contain this information. Comparisons may be made between this indicator and others which are similar to assess the relative emphasis placed on each activity in terms of personnel time.

2D-3: Personnel: Training

2D-3.a. Number of training programs offered for agency personnel.

Sources: Missouri (1982) (1)

Appropriateness: High

Availability: High

Such information should be available in agency records. Programs may be classified according to subject matter or intended audience (e.g., biologists).

2D-3.b. Percent of employees participating in training programs.

Sources: Svoboda (1980) (3), Arizona (1981) (1), Virginia CGIF (1982) (1), Michigan (1984) (1)

Appropriateness: High

Availability: High

Agency training records should contain this information. Programs may be classified according to subject matter or type of employee.

2D-3.c. Number of hours of training provided for new employees.

Sources: Arizona (1981) (1)

Appropriateness: High

Availability: High

Agency records should contain this information. Subject matter of training and type of employee may be specified.

2D-4: Expenditures

2D-4.a. Total annual agency expenditures.

Sources: USFWS (1980) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

Agency fiscal records are the source of data for this indicator. This measure summarizes expenditures by the agency for all purposes.

2D-4.c. Percent of agency expenditures devoted to each purpose.

Sources: Wyoming (1984) (1)

Appropriateness: High

Availability: High

Agency fiscal records should contain this information. Purposes can be categorized according to administrative division (e.g., Enforcement, Fisheries), type of experience (e.g., capital improvements, salaries), or agency program (e.g., hunter education, big game).

2D-5: Data Processing

2D-5.a. Number of reports prepared with data processing office assistance.

Sources: Wyoming (1984) (1)

Appropriateness: High

Availability: High

Agency activity records should contain this information. Type of reports may be specified (e. g., enforcement investigations, water samples, animal ageing).

2D-5.b. Number of species for which a computerized information system is operable.

Sources: Tennessee (1982) (1)

Appropriateness: High

Availability: High

This indicator is relevant only to those states which have such information systems. Data for this indicator would be available in the information system records.

2D-5.c. Number of agency data processing functions which are computerized.

Sources: B. Knuth (4)

Appropriateness: High

Availability: High

Agency records should contain this information. Examples of data processing functions include finances, personnel records, license information, and magazine subscriptions.

2D-5.d. Number of communications hardware devices which are in agency use.

Sources: Oregon (1982) (1)

Appropriateness: Moderate

Availability: High

2D-6: Rules/Regulations

2D-6.a. Number of unsolicited public requests for information on agency rules and regulations.

Sources: Michigan (1984) (1)

Appropriateness: High

Availability: High

Unsolicited requests for information may indicate that rules are not publicized well or are not easily understood by the general public. This indicator does depend on a public knowledgeable enough and law abiding enough to know where to get the information and to want to get the proper information. Data

for this indicator should be available in agency information office records.

2D-6.b. Number of unsolicited public complaints regarding agency rules and regulations.

Sources: Michigan (1984) (1)

Appropriateness: High

Availability: High

Agency information office records should contain these data. Unsolicited complaints indicate rules and regulations are not meeting with public approval and may need to be examined or revised.

2D-6.c. Number of revised rules and regulations.

Sources: Arizona (1981) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

This information should be available in agency administrative records. Many rules changes every year may indicate the need for research as to what regulations would be most appropriate over the long term. Frequent changes in agency regulations are often confusing to the public.

2D-6.d. Percent of regulations written which are consistent with other agency policies and agreements.

Sources: Oregon (1982) (1)

Appropriateness: High

Availability: Moderate

2D-6.e. Percent of resource users complying with regulations on resource use.

Sources: Glass and Maughan (1984) (2), Paragamian (1984) (2)

Appropriateness: High

Availability: Low

2D-6.f. Average value on law complexity scale for agency regulations, as judged by resource users.

Sources: Giles (1978) (3)

Appropriateness: High

Availability: Low

2D-6.g. Number of days of commission (or directors') meetings devoted to rule and regulation revision.

Sources: Oregon (1982) (1)

Appropriateness: Moderate

Availability: High

3D: OUPUTS-ADMINISTRATION

3D-1: Land Available for Recreation

3D-1.a. Number of properties leased by agency to provide recreational lands for public use.

Sources: Idaho (1978) (1), Arizona (1981) (1), Wyoming (1984) (1)

Appropriateness: High

Availability: High

These data should be available in agency records. Leased lands are an alternative to agency-owned lands for public recreation and to requiring citizens secure permission on an individual basis to use privately-owned lands. Leased properties may be classified according to location (e.g., management districts) or type of use (e.g., fishing lakes).

3D-1.b. Number of acres (ha) of lands available for public recreation.

Sources: USFWS (1980) (1), Everest and Summers (1982) (2), USDI and USDC (1982) (1), Wyoming (1984) (1), Owen et al. (1985) (2)

Appropriateness: High

Availability: Low

Public recreation lands may be categorized according to ownership type (e.g., federal, private), use policy on private lands (e.g., unrestricted, leased, by permission only), or recreation type (e.g., hunting, viewing, fishing). Data for this indicator should be available in state land records for publicly owned and some privately owned areas. Data for other areas may be available in records on landowner contracts and general habitat surveys. In 1986 the USFS and SCS are conducting the National Private Landowners Survey to gather data on acres and ownerships available for public recreational access. These data may become available for state use. Federal data may be available in the USDA Forest Service Recreation Information Management System. This indicator requires knowledge of the land base in terms of recreation opportunities available, accessibility of those opportunities, and ownership arrangements. Field verification of ownership records to determine actual recreation potential and accessibility may be necessary.

3D-1.c. Number of recreation areas by ownership type and recreation opportunity available.

Sources: Bisselle et al. (1971) (3), Idaho (1978) (1), Charbonneau and Lyons (1980) (2), Epperson (1980) (2), Irland and Rumpf (1980) (2), Kaiser and Moeller (1980) (2), Missouri (1982) (1), Outdoor Recreation Policy Review Group (1983) (2), Michigan (1984) (1), Kansas (1985) (1), Owens et al. (1985) (2), Snepenger and Ditton (1985) (2)

Appropriateness: High

Availability: Low

Data for this indicator are available in sources discussed in section 3D-1.b. This measure indicates the distribution of recreation areas according to type of opportunities and ownership.

3D-2: Articles/Reports

3D-2.a. Number of manuscripts written by agency employees and accepted for publication or published.

Sources: Wyoming (1984) (1)

Appropriateness: High

Availability: High

Personnel activity reports should contain this information. Publications may be categorized according to discipline (e.g., wildlife, fisheries) or type of publication (e.g., refereed journal, symposia proceedings).

3D-2.b. Number of reports presented at scientific or professional meetings.

Sources: B. Knuth (4)

Appropriateness: High

Availability: High

This information should be available in personnel activity reports. Type of meeting (e.g., national, regional) and type of presentation (e.g., oral, poster session) may be specified.

3D-2.c. Percent of agency publications coauthored with other researchers.

Sources: National Science Board (1981) (2)

Appropriateness: Moderate

Availability: Moderate

3D-2.d. Percent of articles in a given journal attributable to work performed in state.

Sources: National Science Board (1981) (2)

Appropriateness: Moderate

Availability: Low

3D-3: Multiple Use of Holdings

3D-3.a. Percent of state management areas managed for >1 species or recreation activity.

Sources: Epperson (1980) (2)

Appropriateness: High

Availability: High

This information should be available in agency records or planning documents. Particular species or type of recreation activity (e.g., viewing, hunting, fishing) may be specified.

3D-3.b. Number of state management areas managed for >1 species or recreation activity.

Sources: B. Knuth (4)

Appropriateness: High

Availability: High

Data availability and presentation are as described in 3D-3. a.

3D-4: Personnel: Productivity

3D-4.a. Number of staff presented with agency service awards.

Sources: Giles (1978) (3), Anonymous (1985) (2)

Appropriateness: High

Availability: High

Assuming an agency has an established awards program, these data would be available in agency records. Type of service may be specified if awards are given for several reasons.

3D-4.b. Number of publications or professional presentations per person.

Sources: Leary (1985) (2)

Appropriateness: High

Availability: High

Personnel activity reports should contain this information. Use of this indicator to evaluate productivity is appropriate for personnel in a research-track or other position which would require dissemination of results of activities. It is not appropriate for other employee positions.

3D-4.c. Percent of requests for professional comment received which are met.

Sources: Maryland (1985) (1)

Appropriateness: High

Availability: High

This information should be available in agency activity records. This indicator is expressive of environmental review divisions which receive regularly requests for comments on potential environmental impacts.

3D-4.d. Number of quality arrests (defined by agency goals) per enforcement hour.

Sources: Cowles (1979) (3)

Appropriateness: High

Availability: Moderate

Enforcement time and arrest data should be available in personnel activity reports. Quality arrests are defined by the seriousness of the violation and agency goals as described in Cowles (1979). Once the concept of quality arrests becomes operational in agencies, data for this indicator will be more easily obtained.

3D-4.e. Ratio of number of arrests to number of violators, determined by survey.

Sources: Ritter (1979) (3), Giles (1978) (3)

Appropriateness: High

Availability: Low

3D-4.f. Number of hours spent in professional service activities (e.g., conferences, workshops) which update the performance level of personnel.

Sources: Missouri (1982) (1)

Appropriateness: Moderate

Availability: High

a

3D-4.g. Average number of hours worked per day.

Sources: Chandrasekar (1981) (2)

Appropriateness: Moderate

Availability: High

3D-5: Personnel: Safety

3D-5.a. Number of accidents, attacks, or shootings reported by agency personnel.

Sources: Missouri (1982) (1)

Appropriateness: High

Availability: High

Agency records should contain this information. Accidents may be categorized by location (e.g., field, office), or by type of injury.

3D-5.b. Number of workers' compensation claims filed.

Sources: Missouri (1982) (1)

Appropriateness: High

Availability: High

Compensation claims should be available in agency personnel office records. Claims may be categorized according to type of injury or personnel category.

3D-5.c. Amount of money spent in meeting workers' compensation claims.

Sources: Missouri (1982) (1)

Appropriateness: High

Availability: High

Agency fiscal records should contain this information. Claims may be categorized as in 3D-5.b.

3D-5.d. Number of safety inspections conducted.

Sources: Virginia CGIF (1982) (1)

Appropriateness: Moderate

Availability: High

3D-5.e. Number of safety courses offered to agency personnel.

Sources: Missouri (1982) (1)

Appropriateness: Moderate

Availability: High

4D: IMPACTS-ADMINISTRATION

4D-1: Personnel: Morale

4D-1.a. Percent per year of employees leaving agency before retirement.

Sources: Missouri (1982) (1)

Appropriateness: High

Availability: High

Personnel division records should contain this information.

Agency exits may be categorized according to type (e.g., firing, resignation) or personnel category.

4D-1.b. Average number of years spent within the agency per employee.

Sources: Judy et al. (1984) (3)

Appropriateness: High

Availability: High

This information should be available in records of the personnel division. Length of stay with an agency is indicative of satisfaction.

4D-1.c. Percent of national average biologists' salaries paid to average biologist, adjusted for cost-of-living differences.

Sources: Sullivan and Brome (1984) (2)

Appropriateness: High

Availability: High

These data may be obtained from the American Fisheries Society.

Salary has a great effect on employee morale.

4D-2: Use of Agency Reports

4D-2.a. Number of requests received for copies of agency reports or publications.

Sources: B. Knuth (4)

Appropriateness: High

Availability: High

Agency information division records should contain these data.

4D-2.b. Number of times agency reports or publications are cited in selected literature.

Sources: B. Knuth (4)

Appropriateness: High

Availability: Moderate

Reviews of selected literature sources would be necessary to obtain this information. Science Citations Index and Social

Science Citations Index may be useful references in which to find citations for widely available agency documents.

4D-3: Political Influence

4D-3.a. Number of legislative issues for which agency provided legislature with testimony or other information.

Sources: Oregon (1982) (1), Michigan (1984) (1)

Appropriateness: High

Availability: High

Agency activity reports should contain this information. Type of issues or information may be specified. Advice solicited by or presented to the legislature indicates the influence of the agency in guiding legislative actions.

4D-3.b. Number of requests received for agency review of legislative actions.

Sources: Monroe (1982) (2)

Appropriateness: High

Availability: High

These data should be available in agency records. Legislative actions which may require agency review include policy and regulation revisions, and approval of political appointments.

4D-3.c. Number of agency projects receiving increased funding.

Sources: Giles (1978) (3)

Appropriateness: Moderate

Availability: High

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