ESTABLISHMENT OF A DEPARTMENTAL MONITORING PROGRAM

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ABSTRACT

This paper sets out details of a monitoring program to be established within the Department of Conservation and Land Management. Monitoring is to become an integral part of management in order to build the information base on which all management decisions are made. Each monitoring project will be a response to a perceived gap in knowledge and will be established within an experimental management framework. Monitoring will be at permanently marked sites and will involve a graded series of simple, standardised field sampling methods. A new computerised data base will be developed to support the monitoring program including the analysis of results and provision of observer feedback.

The paper also outlines procedures whereby management policy, strategies and programs are to be regularly and systematically reviewed in the light of results from the monitoring program.

The system is to be phased in over the next 10 years, with two initial pilot programs to be commenced immediately in each management district.

INTRODUCTION

Effective long-term management of Departmental lands (and waters) involves many activities, of which three are particularly important:

- Setting clear management objectives,
- Undertaking management to achieve those objectives, and
- Evaluating the effects of management in relation to objectives.

The process of planning and management necessitates predicting the consequences of a range of options (including the do-nothing option). For many areas under Departmental control, the knowledge that should form the basis for such predictions is lacking. Furthermore, this knowledge will not be available in the foreseeable future. The Department does not have the resources to commission immediately all the research that would be necessary to gain that knowledge. More importantly, it cannot afford to postpone management decisions until the research is done.

Evaluation of management decisions and actions can occur on a range of time-scales that will reflect the nature of objectives. Generally, Departmental lands are managed for long-term objectives such as maintaining the sustained yield of sawlogs from forests or ensuring the persistence of species of plants and animals. However, there is a need to establish procedures to evaluate whether objectives are being met.

A Departmental policy on ecosystem monitoring and management has recently been adopted. This prescribes the establishment of a series of monitoring sites on Departmental lands (and waters) throughout the State and a program for systematic sampling of those sites. Management of Departmental lands will continue but the effects of management will be monitored. Results from the monitoring program will be assessed and used in making subsequent

management decisions. In this way, the monitoring program will contribute to a gradual improvement in knowledge and in management.

A third, important justification for the Departmental monitoring program follows from the need to maintain an up-to-date knowledge of the distribution of plant and animal species and their habitats throughout the State. To fulfil this need it is necessary to establish a series of biological benchmark or reference sites and to resurvey those sites on a regular (if infrequent) basis. Monitoring of benchmark sites will also provide some insight into rates and directions of natural change (i.e. in the absence of management intervention) in communities and ecosystems.

This paper elaborates on the aims and the procedures to be adopted in CALM's ecosystem monitoring and management program.

OBJECTIVES OF THE MONITORING PROGRAM

The goal of the monitoring program is to improve management of Departmental lands (and waters) and of the State's biota.

The monitoring program provides a means to achieve this goal in the following ways:

i) Monitoring increases the level of knowledge about the resources being managed;

ii) The program establishes a framework for making better management decisions based on ever-improving knowledge and on regular review;

iii) The implementation of management decisions becomes more accountable and will improve as a consequence; and

iv) The monitoring program provides a focus for cooperative activity throughout the Department and with the wider community; this leads to more efficient and effective use of Departmental resources.

The specific objectives of the monitoring program are to maintain up-to-date records of the distribution and status of the State's biota, the management decisions that are made about that biota and about Departmental lands (and waters) and the consequences of those decisions and to provide a mechanism for systematically reviewing management policies and programs in the light of new information.

BACKGROUND: THE REQUIREMENTS OF THE MONITORING PROGRAM

Bisset and Tomlinson (1981) define monitoring as "the process of repetitive observations of one or more elements or indicators of the environment according to pre-arranged schedules in time and space in order to test postulates about man's impact on the environment". They identify two key features: repeated observations according to a pre-arranged schedule and testing hypotheses about impacts. This definition is in general agreement with that given by Hellawell (1978) for water quality monitoring except that the latter author refers to measurements against previously formulated standards. Hellawell (1978) distinguishes monitoring from surveillance which involves systematic and repeated sampling to obtain time series data.

A monitoring program that meets the comprehensive needs of a land management agency may embrace surveillance and monitoring. In addition it must also meet the following requirements.

i) The methodology has to be simple and attractive to a range of users.

ii) The system must provide useful results, i.e. results which are interpretable and applicable.

iii) Each monitoring project within the overall program must have clearly stated objectives.

iv) The program must incorporate procedures for systematic evaluation of results with provision to review management policies, strategies and programs.

v) The methodology adopted must be sufficiently flexible to accommodate the range of objectives, organisms and environments to which they will be applied.

vi) The system should incorporate mechanisms to ensure continuity of observations in the long-term (>30 years).

vii) Procedures must be cost-effective.

THE MONITORING PROGRAM FOR CALM

The system that has been selected for CALM has the following features:

i) All monitoring is site based. Each monitoring site is permanently marked and identified.

ii) Monitoring procedures are standardised as far as possible to ensure compatibility of data from year to year and from project to project. Observer error is therefore minimised.

iii) The monitoring procedures are graded so that, for each project, only the minimum set of relevant data is collected.

iv) The system has a record-keeping component with an additional function to provide regular feedback to observers. The feedback cycle is important to sustain interest and to maintain data quality.

v) Monitoring is an integral part of management.

A key requirement is that a new record keeping system is established within the Department to ensure that information on all management decisions (including decisions to do nothing) and the reasons for those decisions are properly stored and can be retrieved. There will be a requirement that significant management decisions and actions be recorded and fed into this system. There will also be a requirement to report on the immediate results of all management actions. Provision will also be made within the record keeping system to store information of a general kind relating to any area of Departmental land.

EXAMPLE

An example of how this part of the monitoring program should operate is provided by the following hypothetical case.

A reserve manager conducts a routine inspection of a national park. He considers that the area looks to be in good condition and decides that no management action is necessary. This decision and the reason for it is recorded and stored. A year later the manager visits the park again. He observes a major infestation of weeds that could spread throughout the park. He records the observation including precise locality and date and decides that an eradication program is warranted. After looking at work schedules, a program involving weed pulling and limited direct application of a hormone spray before plants produce seed is designed. The prescription is recorded. At the appropriate time the management team goes to the site and implements the control/eradication program. The implementation of the management program is recorded together with an opinion of the success or otherwise of it. Subsequently the manager revisits the site and records the extent of the weed death and any further invasion and the need for any further work at the site.

All these written records and observations go onto a local file on the park. A note must also go to the central, computerised record system to the effect that no action was necessary in Year 1 (the do nothing decision) and action was required and undertaken (successfully) in Year 2.

The procedures described here emphasise the recording process. In fact most cases the actual decision on control measures is difficult because the manager may have little information on the biology of the weed and its likely impact on the park and may know nothing about suitable control measures. He will seek and get advice but may well decide to use the opportunity to learn about the weed and about control techniques. To do this he should initiate a small scale monitoring program involving regular site visits and

standardised observations. This should be done in collaboration with a research scientist to assist in the design of the monitoring program and the interpretation of the results. Together the research and management personnel will then prepare a brief report on the weed and its control.

FIELD MONITORING

The approach to a field management problem described above introduces the concept of field monitoring that is the cornerstone of CALM's approach to ecosystem management.

In general, the decision to initiate a field monitoring project will be a response to an identified gap in knowledge. Therefore each project will be able to have a clearly stated objective. It is desirable to express the objective as a hypothesis to be tested because this aids decisions on sampling methodology and subsequent analysis of results.

All field monitoring will be at permanently marked sampling sites and using simple, standardised recording techniques. There will be a gradation of sampling methods ranging from simple, repeat photography to comprehensive biological survey. This will allow the user to select a method to collect the appropriate minimum data set. In addition, there will be a minimum set of baseline data to be collected at each site at the time of establishment of that site.

EXAMPLE

In the case of the weed infestation in the national parks the manager could monitor the effects of his control measures at either one of two levels of detail. The most basic level involves taking photographs of a fixed point from a fixed photopoint, 10 m to the north (Fig. 1). The photographs would be taken prior to treatment, immediately after treatment and at regular intervals thereafter for up to 3-4 years. Photographs would be supplemented by brief notes.

A more detailed level of monitoring would involve measuring plant canopy intercepts along the transect lines illustrated in Fig. 1. It would be necessary to record

intercepts for the species of weed and for 3 or 4 species of native plants to determine effects of the weedicide on these species.

FIG. 1 ABOUT HERE

In each case the manager would establish at least one monitoring site in the area to be treated and a control in an untreated area nearby. He would also record some fundamental data about each site including site number, site type and project description (project objectives) and a variety of biophysical details of the site (landform, soil, hydrology/drainage, vegetation type and condition).

For each monitoring site there should be a departmental file to contain site observation records and photographs. The file should also record land classification details, site access details, map grid reference, airphoto details and source and availability of meteorological information for that site.

Photography is a very convenient monitoring technique. It can provide useful data over a long period provided there is adequate standardisation (e.g. Noble 1977). Photographs are a very important tool for communicating the nature of changes that may occur over time. However, photographic monitoring has two principal disadvantages. It is often difficult to explain the changes that may be interpreted from photographs. Secondly, photography does not readily produce quantitative data suitable for incorporation into a computerised data base. This latter disadvantage may be remedied through the use of horizontal stereo-photography: the Department is currently evaluating a Micro-photogrammetric System (MPS-2) for use in general forest inventory and monitoring.

As the first step in implementing the monitoring program, a Field Monitoring Procedures Manual will be produced. This will outline in detail the actual steps to

be taken to establish a monitoring site and to record appropriate information at that site. A key to aid in the selection of methods is also envisaged; this key will ask questions about the objectives of the particular monitoring project being set up.

It will also be important in the early stages of implementing the monitoring program to review the many existing Departmental monitoring activities and to integrate them into the new program as far as possible.

PLANNING AND EXPERIMENTAL MANAGEMENT

Many conservation and land management decisions are perforce made with only partial knowledge of the resource and the consequences of management. This problem exists within planning process as well as at the level of day-to-day management.

There are two measures which must be adopted to minimise problems stemming from this situation. Firstly, the planning and decision making process must be used consciously to identify gaps in knowledge. By identifying study needs in this way, relevant research programs will follow. Furthermore, managers and planners are well placed to decide on priorities for studies to fill the gaps.

Secondly, each management action must be designed as an experiment to improve the knowledge base. To do this effectively, each planning and mangement decision should be expressed in the form of an hypothesis which can then be tested. As an example of this, we return to the hypothetical case of the weed invasion in the national park. Under normal circumstances the park manager may well make his decision on weed control/eradication thus: On the basis of available information, the best guess is that application of hormone spray x will provide effective long-term control of this weed species at the particular site in the park. If, however, the management decision is expressed as an hypothesis then an experimental management framework is established: Application of the hormone spray x to control weed species y at that site in the park will eradicate the weed and will not adversely affect the native vegetation. Stated this way, the objectives of the subsequent program of study become clear and the type of data to be collected is identified. In this case it will be necessary to record presence/absence of the weed species over a 2-3 year period and to record observations on death of native plant species in the vicinity. The actual design of the monitoring project that will ensure that the results are useful and

capable of being interpreted will be developed by the park manager using the Procedures manual.

Acceptance of the principle of experimental management implies a change in the roles of planners and managers with a consequential change in the role of researchers. Planners will become more involved in the design of studies to fill the knowledge gaps as identified and managers will become involved in the implementation of those studies and the subsequent evaluation of the results. Planners will call upon the researchers to assist in the design of management experiments and managers will seek assistance during the recording and evaluation phase.

PRIORITIES FOR MONITORING

The extent of the gaps in knowledge will make it impractical to address every management problem through a properly designed, rigorous, scientific research program. There will not be sufficient resources to do the work. Furthermore, neither planners nor managers have the luxary of waiting for the results of research before taking action to deal with the problems.

One approach is to use monitoring procedures to gather the necessary data to test the mangement hypotheses. The experimental management framework provides a sound basis for identifying what information should be gathered and the monitoring program provides a range of simple sampling methods and a data mangement system to collect and analyse that information. The simple monitoring procedures can be implemented by the manager at little additional costs; thus the integration of monitoring with management becomes a practical proposition.

Despite the efficiency of the monitoring procedures, it will still not be feasible to implement monitoring projects to evaluate every management action and to address every gap in knowledge immediately. It will be necessary to establish priorities for monitoring. It will take some time to develop priorities; a task that will best be done by planners and managers in collaboration. Monitoring needs can be identified by both groups but only managers know the practical limits to what monitoring can be achieved. At the same time, planners have the broad perspective to enable them to rationalise monitoring needs between particular reserves, districts and regions. Some coordination is essential to minimise duplication in monitoring projects whilst ensuring that important issues are addressed.

RESEARCH AND MONITORING

Monitoring is not a substitute for properly designed experiments. It is complementary and supplementary to survey work and detailed research.

Establishment of each monitoring site will involve the collection of some basic information about that site. This information will rarely be as comprehensive at that required for a biological/ecological survey. But for many sites it may be the first and only set of data. It must be collected in a manner that is compatible with existing survey methods. Thus there will be a gradual input into the biogeographic data base through the monitoring program.

The results of individual monitoring projects will also be valuable to researchers in looking at issues at the generic level. The monitoring projects will tend to be focussed on particular problems at particular locations. But many of the problems are widespread. With effective coordination, these common problems can be addressed through monitoring projects at several localities across the landscape. Through this coordinated approach the monitoring program will produce results that represent more than the sum of the component projects. In effect, monitoring will extend the research capabilities of the Department.

It is likely that some researchers will draw on the methods outlined in the Field Monitoring Procedures Manual to establish monitoring sites and to gather low-cost data for verification of research results.

Long-term ecological research embraces monitoring (cf. Callahan 1984, Likens 1988). But there are many long-term ecological research sites where monitoring does not occur at present; these sites are places where many, often discrete, studies have been conducted over a long period but where no type of data have been collected systematically throughout that period. It is desirable that appropriate monitoring

projects be established at these sites to facilitate better integration of the individual studies. Monitoring of a few key, functional variables will provide continuity from one study to the next.

EXISTING MONITORING PROGRAMS

There are many existing Departmental activities that fall within the concept of monitoring as outlined here. The forest inventory plots are regularly resampled to gain information on tree growth rates. There are many wetlands with depth gauges that are read bimonthly and where water samples are taken. Populations of Noisy Scrub-birds at Two Peoples Bay Nature Reserve and the several reintroduction sites are monitored though systematic recording of male territorial calls. Kangaroos are monitored by aerial survey. And ecological surveys conducted through the Research Division are all designed and established to permit replication of sampling. All these existing monitoring activities should continue. As the larger Departmental monitoring program develops there may well be merit in coordinating these existing activities.

Outside the Department, a wide range of biophysical factors are monitored by many agencies and using different methods. Climate and weather monitoring is undertaken by the Bureau of Meteorology. Environmental agencies look at air and water quality parameters. The condition of vegetation on pastoral lands is monitored by managers using both foxed points with on-ground sampling methods and low level aerial photography and attempts are being made to use multi-spectial scanning techniques (e.g. Friedel and Shaw 1987 a,b; Graetz et al. 1986; Graetz and Pech 1987). Some of these agencies are using a common computerised data base management system, WARIS (Worldwide Application Resource Information System), which was developed by the Queensland Department of Primary Industries (see Walker et al. 1973).

At an even broader scale, global networks of environmental monitoring sites are currently being established in order to accumulate standardised observations on land, sea and air and to coordinate interpretation of the data (Dyer et al. 1988; Gwynne 1987). There is clearly

potential for the CALM monitoring program to be placed within the broader context at some time in the future.

EVALUATION OF RESULTS

CALM's monitoring program involves the identification of management problems, the establishment of projects to resolve those problems and the management of the data from monitoring. For this new information to be of maximum value there must also be a mechanism for evaluation of the results of monitoring projects and for review of management decisions in the light of those results.

The cyclic process of planning and management is illustrated in Fig. 2. This process provides for evaluation and subsequent review of policy and management strategies and plans.

FIG. 2 AROUND HERE

Results of each monitoring project should be evaluated on an annual basis. The evaluation should take place following receipt of new data and should address the following questions:

i) Are the new observations reliable - have the data been correctly recorded and do they seem to make sense?

ii) Is the project continuing to provide information relevant to the objectives - should it be continued or discontinued?

iii) Are the results consistent or inconsistent with expectations - should there be a review of management policy, strategies or programs?

The responses to these three questions should be recorded on the files for each project and should also form part of the regular feedback to observers.

To ensure that the relevant results of the monitoring program are used in subsequent management decision-making,

results of each project should be published on a 3-4 year interval. Project reports should be widely circulated within the Department. By bringing results to the attention of decision-makers it is expected that review of management policy strategy and programs will become axiomatic.

In addition to the individual monitoring project reviews, there should be regular reviews of themes within the monitoring program. The timing of these thematic reviews should relate to reviews of relevant policy but it should not occur any less often than every 5 years.

SUMMARY OF BENEFITS OF THE MONITORING PROGRAM

The monitoring program has been designed to meet the needs for increased information about the resources being managed and the effects of management actions on those resources. The program will improve our knowledge base and lead to gradual improvements in management.

The monitoring program is designed to be efficient and cost-effective. It provides a framework whereby all management decisions and actions become accountable. This will allow managers to identify closely with the work they are undertaking. The monitoring program will also enable the Department as a whole to justify its existence in years to come. The Department will be able to show how it is achieving its objectives and, where the objectives weren't being achieved, how management policy, strategies and programs have been modified to improve the level of achievement.

As the monitoring program is designed, much of the work will fall on the field managers. Monitoring will become an integral part of management. But the process of designing and implementing and analysing monitoring projects will also involve policy makers, planners and researchers. Monitoring will become a focus for collaborative work within the Department.

As a further benefit, the monitoring program can provide a vehicle for public involvement in management. Local interest groups can be invited to participate in simple monitoring projects. They will learn more about the places and things being monitored and may well come to better understand the issues involved in conservation management. The Department will benefit from the information collected at low cost by the public groups.

Secondly, where public or industry groups apply to use Department lands for an activity that could be potentially

damaging, then those groups can be required to monitor impacts of their actions using the standard procedures. This monitoring requirement would provide the basis for judging future applications for use of Departmental lands.

IMPLEMENTATION

It will not be possible to implement the monitoring program throughout the State immediately. Therefore, it is proposed that the program be phased in through the establishment of a series of pilot projects. There are to be two projects established in each District to run for 3-5 years, after which time the monitoring program will be re-evaluated. The two projects are to include one to deal with general patterns of change in the biota in the District and a second to deal with a management issue of particular interest or important to the District management personnel. This second category of project would invovle examining such things as effects of fuel reduction burning, rabbit and cattle grazing, dieback or rehabilitation works.

Establishment of each pilot project will involve close liaison between District management personnel and the monitoring program personnel.

A precursor to establishment of monitoring sites will be the preparation of the Field Monitoring Procedures Manual and the setting up of the appropriate data base. The data base will be set up and operated within the Inventory Branch of the Department.

It is proposed to establish a Monitoring Group within the Environmental Protection Branch to provide the necessary coordination and liaison function, to maintain standards of data collection and to provide the scientific expertise for the regular reviews of results.

Establishment and monitoring of benchmark sites will continue to be a function of the Biogeography Program within the Research Division. However there will be a need for some assistance to be provided by Operational field staff on an occasional basis.

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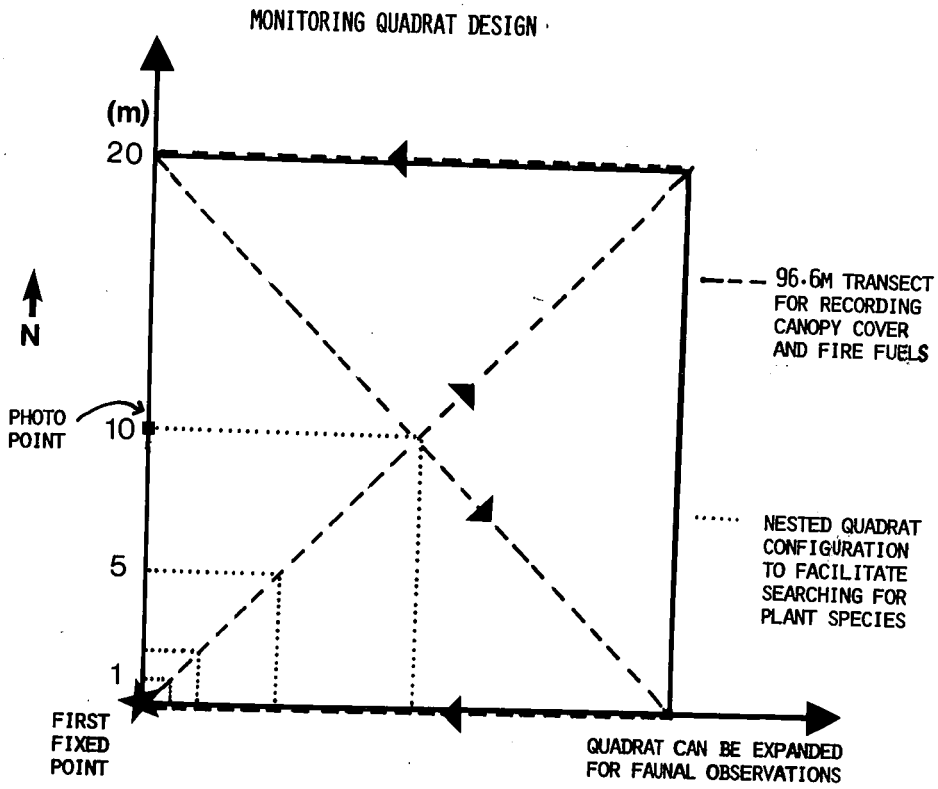
FIGURE CAPTIONS

Fig. 1. Proposed design of quadrats to be used in the monitoring program. The south-western corner is the fixed reference point for all monitoring activities. The photopoint is also fixed at 10 m north of the reference point thereby eliminating light/shadow problems. The sampling quadrat can be of any dimensions to the north and east of the fixed reference point. Quadrats of 10 m x 10 m and 20 m x 20 m have been used for recording plant species while quadrats of 2 km x 2 km have been used for faunal observations.

Fig. 2. A flow chart of decisions on management of natural lands (and waters) illustrating particularly the cyclical nature of the process when a monitoring and re-evaluation phase is introduced.


MONITORING QUADRAT DESIGN
(m)
20
N
PHOTO POINT
10
5
1
FIRST FIXED POINT
96.6M TRANSECT FOR RECORDING CANOPY COVER AND FIRE FUELS
NESTED QUADRAT CONFIGURATION TO FACILITATE SEARCHING FOR PLANT SPECIES
QUADRAT CAN BE EXPANDED FOR FAUNAL OBSERVATIONS

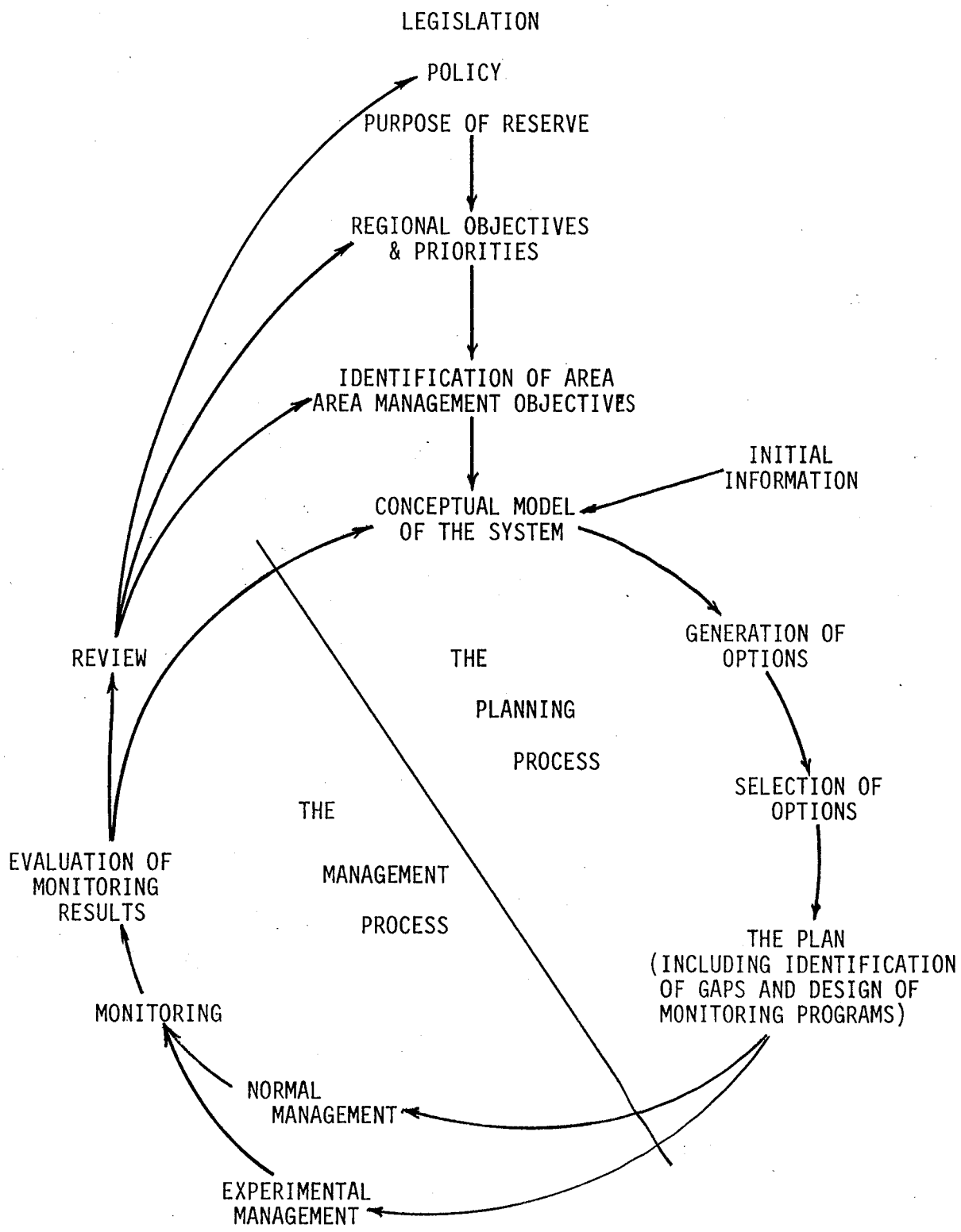

LEGISLATION
POLICY
PURPOSE OF RESERVE
REGIONAL OBJECTIVES & PRIORITIES
IDENTIFICATION OF AREA AREA MANAGEMENT OBJECTIVES
INITIAL INFORMATION
CONCEPTUAL MODEL OF THE SYSTEM
GENERATION OF OPTIONS
SELECTION OF OPTIONS
THE PLAN (INCLUDING IDENTIFICATION OF GAPS AND DESIGN OF MONITORING PROGRAMS)
NORMAL MANAGEMENT
EXPERIMENTAL MANAGEMENT
MONITORING
EVALUATION OF MONITORING RESULTS
REVIEW
THE PLANNING PROCESS
THE MANAGEMENT PROCESS

FIG 2.