guideline

A PARK PRACTICE PUBLICATION

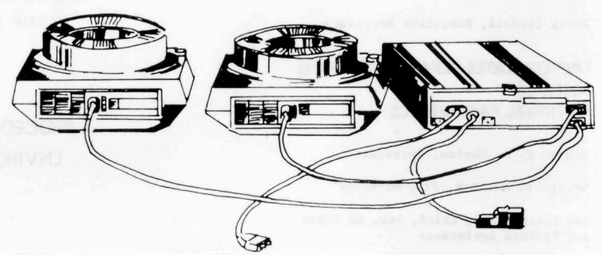
THE NATIONAL RECREATION AND PARK ASSOCIATION
THE NATIONAL CONFERENCE ON STATE PARKS

CONTENTS

Following are the first three installments of GUIDELINE in its new format. Guideline is being published every two months in eight page sections and will be indexed at the end of each year. A new binder is available for GUIDELINE as well as for the other Park Practice publications. For further information contact the National Conference on State Parks, 1700 Pennsylvania Avenue, N.W., Washington, D.C. 20006.

By Ben D. Mahaffey, research associate and instructor, and John W. Hanna, graduate teaching assistant, Department of Recreation and Parks, Texas A&M University. "If the various techniques and procedures discussed in this article are followed," according to the authors, "it will be possible to achieve professional results from modest investments. Three and five projector productions will appear to be productions to the audience, but the basic concepts are simple. These methods will greatly increase the visual sensations and will, hopefully, leave the viewer with a better understanding of your message."Illustrations by Ziza Schofield.

PRINCIPLES OF MULTIPLE PROJECTION



Environmental interpreters, resource managers and educators rely heavily upon audio-visual techniques for communication to the public. However, most of the methods presently used **cannot** compete favorably with color television, wide screen motion pictures and other sophisticated commercial media.

Most visitors to various parks, recreation areas, historic sites and nature centers are accustomed to the use of slide presentations. Even when these standard programs are well prepared and delivered, the visitor may be left with a feeling of "preparation mediocrity." Some administrators may ignore visitor reaction to audio-visual techniques, but the competition and interest from other media remains.

The use of multiple projectors and screens **can** effectively compete to offer new and exciting experiences for viewers. These varied techniques of presentation will help to make your messages command more attention and interest. The following guidelines and suggestions will help you to design and operate multiple projector presentations.

DEFINITION OF TERMS

Multiple projectors (multiple screens)—the use of two or more projectors and screens. Three projector presentations and three and five projector audio-visual booths are discussed in this article.

Screens—the use of three separate screens or one continuous screen or projection surface. The most practical aspect ratio is 2:3 for individual screens or 2:9 for single wide screens or other projection surface.

Vunit—a visual unit. Slides projected side by side on one wide screen, or each slide projected on its own separate screen. The slides can be separate but related **(Figure 1)** or three single images that are put together to form a continuous panorama **(Figure 2).**

Black slide—an opaque material the thickness and size of a slide. These are used to create a vunit of less than three images. Black slides can be constructed by placing opaque material in a conventional slide mount.

WIDE-SCREEN IMAGES & VUNITS READILY ACCEPTED

Psychologists can partially explain why panoramic vunits are readily accepted by the viewer. Items grouped together tend to be viewed as a whole, but often with increased effectiveness (7). Groupings of three are commonly encountered and easily accepted and perceived by the mind. When the object viewed is incomplete, the mind will tend to complete the picture (7). However, it must be remembered that increased visual displays can also increase frustration and confusion (6). There does appear to be a tendency to place too much emphasis on the medium involved and often the communication or message objective is subordinate to the audio-visual technique (2). Planning and coordination is an absolute necessity to prevent this from happening.

It should also be noted that music or narration must effectively **supplement** vunits. When conflict occurs, viewers often reject vunit presentations more readily than they do more simple presentations because of increased visual confusion. Caution should also be given to the tempo or mood that is established by the musical accompaniment. The music must **reinforce** the delivery of the message, or it should be deleted.

Perhaps an easier explanation would be to state that when using more than one of the senses of the body for communication (eyes, ears) each medium must compliment and enforce the other to prevent delay or conflict of the message (5). Although this planning phase is sensitive and creative, it can be accomplished by interpreters, educators and resource managers.

Educators are aware that young people have developed a keen sensitivity to audio-visual methods. This is apparently a result of conditioning by television viewing and various audio-visual methods of teaching. Youngsters (and many older people) have developed abilities to rapidly perceive vunits from habit and extended exposure. This phenomenon requires the use of more images, high quality color and sound accompaniment to command and retain attention from viewers, especially those in a recreational or voluntary environment. The general public has also been made conscious of, and attracted to, the wide screen entertainment from systems such as CinemaScope and Cinerama (1).

EQUIPMENT NECESSARY FOR THREE PROJECTOR PRESENTATION

The following equipment is necessary to produce a three projector presentation **(Figure 3).**

Projectors—Kodak Carousels* are extremely adequate; however, other types are equally acceptable. Each projector should be the same model or series. For optimum results, each machine must project each image exactly the same in size and brightness. The "zoom" type lens provides greater flexibility in adjusting the image than does the standard size lenses.

Screens—Three separate or one wide screen can be used on a single, light colored wall surface. The wide screen or wall surface removes the break in continuity that occurs when using three separate screens. If three separate screens are used they should be the same type and size **(Figures 1, 2).**

Fig. 1. Three slides projected separately but communicating a single concept—a vunit.

Fig. 2. Three slides projected to give a wide—screen or panoramic view—a vunit.

Projection tables—One large or three separate projection tables are necessary. The single table is most desirable because it provides a uniform projection station.

Slides—The number will vary depending upon the subject, type of narration, audience, etc. The number will probably range from 240 to 720, many which will be black slides. There are no hard and fast rules to determine specific numbers (4). The basic objective and message desired should determine the number of slides that are used.

Slide trays—Slide trays will be needed in multiples of three, depending upon the number of slides for the program. Kodak has recently developed a slide tray holding 140 slides, which can be used in place of the 80-slide tray commonly used by most Carousel projectors. When using the Carousel models it is suggested that one vunit series be inserted into the projector at the 81st or 141st positions, in addition to the full tray. When this vunit appears, these trays can be removed and the next series can be placed into position without interruption or breaking the continuity of the program.

Extension cords—Using three projectors usually requires extra power extension cords and extra remote control cords **(Figure 3).**

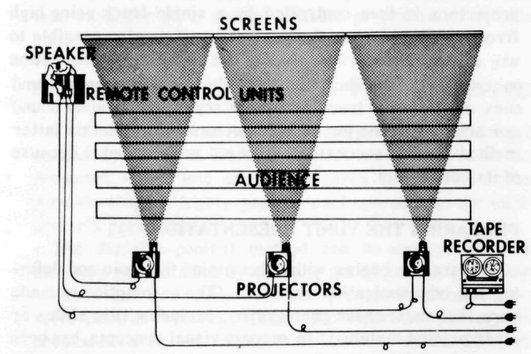


Fig. 3. Layout of equipment needed for multi—image or vunit presentation. The projectors must be high enough to show over the heads of the audience with this type of physical arrangement.

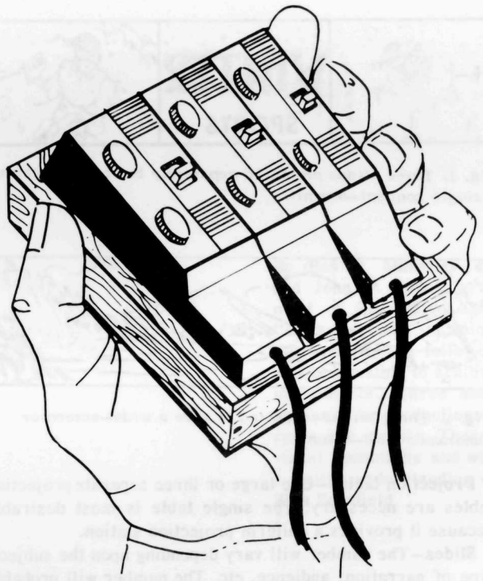


Fig. 4. Remote controls can be arranged on a small board to hold them in position for single or simultaneous operation.

Mount for Remote Controls—A small board can be used to mount the three remote extension cords necessary when hand operating the projectors. Masking tape will hold the controls firmly in position so they can be easily operated with one hand **(Figure 4)**.

Tape recorder—Most presentations are more successful with some type of narration or music. A separate operator can control the musical accompaniment or a single person can activate the sound on the recorder and then handle the projectors and narration. If the narration and music are pre-recorded on tape, a single operator can easily handle the whole operation.

Complete automation-The whole procedure can be automated with a special 4-head tape recorder. The music and narration can be placed on one track. Each of the three projectors is then controlled by a single track using high frequency sound cues for activation. It is also possible to use a 2-head recorder, placing the sound and/or narration on one track and then diverting the high frequency sound cues on the other track into three separate Carousel sound synchronizers (one for each projector). Although this latter method can be successful, it is not recommended because of its complexity.

PREPARING THE VUNIT PRESENTATION

Preparation begins with determining the topic and defining the **communication objective.** (The assumption is made here that most of the photography, excluding title slides or other printed materials to support visual concepts, has been completed.) Other details necessary at this stage of planning are: presentation length desired, nature and background of the audience, special interests needing emphasis and the site for the presentation(4).

Three keys to effective slide presentations are? "Preparation, Practice and Personality" (4). The basic preparation stages for a vunit production are the same as for using single slides. However, much more time and detailed planning is necessary for a vunit presentation. Forty or fifty man-hours of preparation in addition to photographic time is not uncommon.

The **basic** communication objective must be well defined before assembling the individual vunits. In addition to having an overall objective in mind, each individual vunit must be planned **(Figures 1, 2 and 5).**

Research has indicated (3) that viewers enjoy and accept the opportunity of learning by more than one medium and actually prefer combinations of media or varieties to a single medium. The greatest advantage in using multiple projectors is flexibility in presentation (1). This can be achieved through the use of a variety of vunits, including the panorama or combinations of images and written material which can be supplemented by music and/or narration. The basic philosophy of the planner sould be: "How can I **best** communicate the message that I wish the viewer to perceive—**and** entertain and hold his attention at the same time?"

A light table provides an ideal and effective surface for arranging the vunits **(Figure 5).** The slides should be arranged in three columns with the left column corresponding to the left projector (facing screen), center column the middle projector and the right column the right projector.

Various combinations are possible using the vunit system. The projectors can be operated independently or simultaneously. Three images need not be used on every vunit **(Figure 6).**

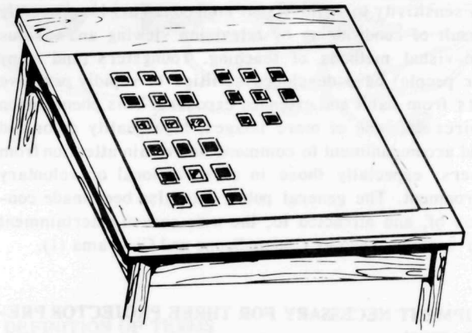


Fig. 5. A light table provides an easy base for planning the presentation. Slides should be arranged in columns corresponding to each projector.

Two basic methods for activation of the projectors can be used: a) each projector operated independently and each sequence for each projector memorized by the operator; and b) all projectors operated simultaneously, but vunit patterns manipulated on the screen by using black slides **(Figure 6).**

The above techniques are designed for hand manipulation. If total automation is desired, using a 4-head tape recorder, each projector is activated independently. If a 2-head tape recorder is used, diverting the high frequency sound cues into three separate sound synchronizers, all projectors must be activated simultaneously.

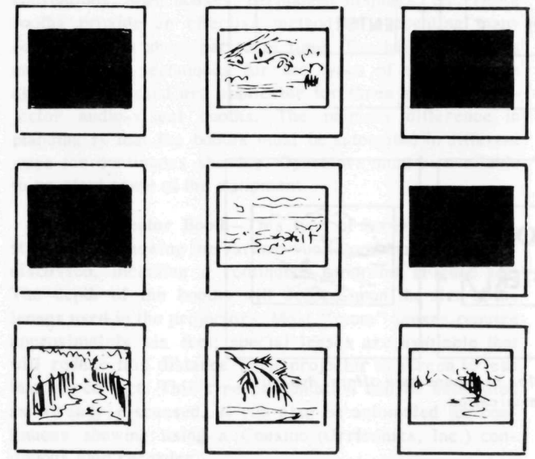


Fig. 6. Black slides can be used to manipulate the number of images when using the simultaneous activation method.

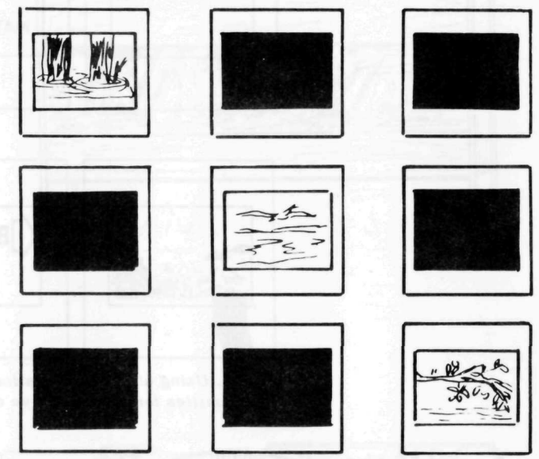


Fig. 7. Each row of slides represents a vunit as it will appear on the screen.

For optimum effectiveness, the vunits should be used in the various combinations possible, offering a pleasing serendipity for the viewer: One, two or three slides, independently or in unison; slides appearing in progression from the left or from the right; panoramas occasionally for special impact; and supplemental title slides for concept emphasis **(Figure 7).**

A presentation can be simple, using the center screen for several introductory slides, then suddenly presenting three at one time. A concept might be developed by introducing slides from left to right, one at a time, (figures 6, and 7.) An important concept could be presented dramatically with a negative presentation on the left and the positive presentation on the right.

An example is demonstrating the results of a clean-up campaign with before and after shots in one vunit **(Figure 8).** Title slides and other supplemental graphic materials work effectively in the vunit. Using a panorama for the title to a presentation is also pleasing **(Figure 8).**

If it is desired to leave a single image on a screen using the simultaneous activation method, then duplicate slides will be necessary, repeating the same slide on subsequent vunits. (The simultaneous activation method is the most accurate for hand manipulation because each sequence for each projector does not have to be memorized.)

After the initial preparation of the slides is completed, they should be cleaned and placed in the slide trays for preliminary viewing. Some rearranging and slide replacement will probably be necessary. Ideally, the projectors should be placed as far apart as the distance between the centers of each screen to avoid parallax **(Figure 3)** but satisfactory results can be obtained if closer placement is necessary. A vunit of black slides should be used at the beginning and end of each presentation to prevent flooding of light on the screens.

After a couple of initial previews, rehearsal for timing and sequence delivery should begin. Practice should continue until a complete familiarization is accomplished. The preparation of an operation script and narrative script will probably be necessary for the longer or more difficult presentations. However, for a truly professional performance, many interpreters may wish to delete the use of the scripts. This expertise can be accomplished only by extended rehearsal sessions (4).

If automation is desired, the above procedures are necessary until the presentation is smooth enough to record sound and activation cues on the recording tape. It is suggested that automation be completed in segments, which reduces the overall preparation time. Details for automation are not given in this article because of the various types and models of recorders. However, it will take a 4-head tape recorder or a special console programmer to completely automate the three projector presentation.

DISSOLVE-CONTROL UNIT FOR FADE-OUT EFFECT

Two projectors can be used to project slides on a single screen by using a dissolve-control unit which fades one projected image into another **(Figures 9, 10).** This procedure develops a highly professional approach to the interpreter's presentation.

The dissolve-control method can be incorporated into the vunit presentation by doubling the number of projectors involved and activating each two projectors through a dissolve-control system. The basic operation of a vunit presentation is not changed using these units. However, the number of slides used will probably be fewer because of the added time necessary for image fade-out **(Figures 9, 10).**

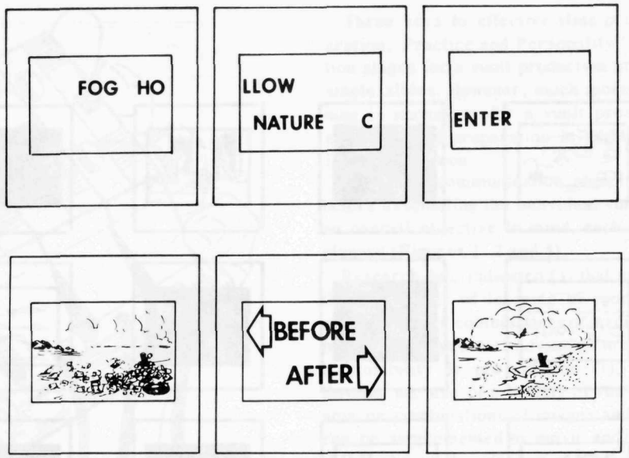


Fig. 8. Using all three slides for titles in a panorama offers dynamic opportunities for more effective communication.

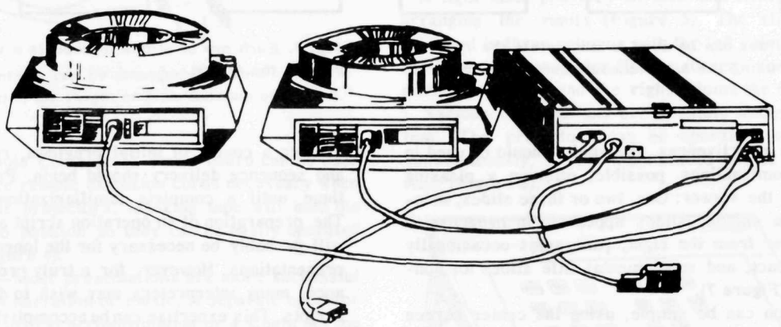


Fig. 9. Two projectors can be used to project slides on a single screen by using a dissolve control unit which fades one projected image into another.

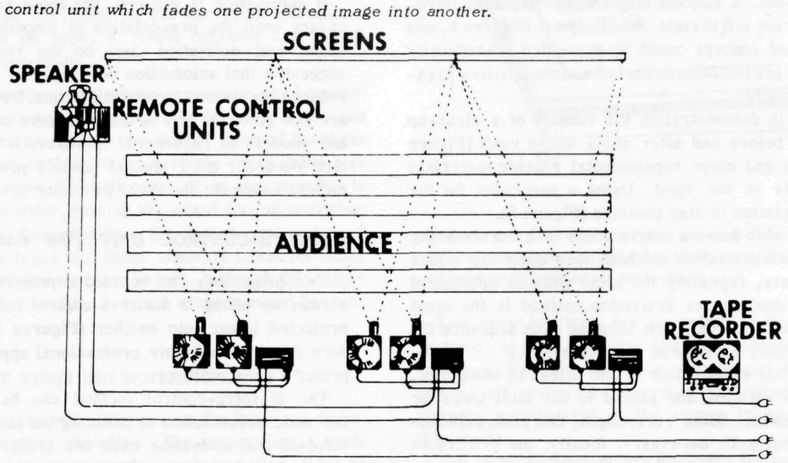


Fig. 10. A series of dissolve-controls can be incorporated into the vunit presentation by doubling the number of projectors and activating each two projectors through a single dissolve-control unit.

REAR PROJECTION BOOTHS

This type of audio-visual fixture is useful for fairs, conventions, open houses, permanent displays, etc. These booths provide an effective method of presenting many concepts in a short period of time. The basic principles and planning techniques for the types of presentations already discussed are applicable for three and five projector audio-visual booths. The primary difference in planning is that the booths must be automated in different ways for continuous showing. Operators must be available to re-start some of the equipment.

Three Projector Booth—This type of booth can be constructed for showing the various vunit combinations already discussed, including a continuous panorama (**Figure 11**). The depth of the booths will depend upon the size of the lenses used in the projectors. Most "zoom" lenses require approximately six feet; special lenses are available that will reduce this distance from projector to screen to less than three feet. This type presentation can be automated as already discussed. It can also be automated for continuous showing using a Cousino (Orrtronics, Inc.) continuous loop recorder.

Five Projector Booth—This type of booth, although impressive from the audio-visual standpoint, is rather limited in the variety and method of use. The five projectors necessary for operation require diverting the high frequency sound cues from one tope track into five separate sound synchronizers. Sound can be used independently of projector activation. If this is done, each projector must operate independently, using the timed activation control lever present on most projectors. If music and/or narration is used with the latter method, it must be general enough in timing to allow for variance in the automatic timing mechanisms of each projector. A special console programmer can be built to operate all fivr projectors and sound, but the price procludes use by most organizations.

The number of screen surfaces appears to prevent the use of several independent themes. Therefore the planner must make a single, cohesive theme which is readily understood by the viewer. The nature of the message will determine the length of time each slide will appear on each screen. Most projector controls vary from five to twenty seconds. Although each image must appear independently, the booth has several interesting application possibilities for the planner.

Reverse Screen Materials—A special reverse screen is necessary for rear projection. One material available is "Len-screen," manufactured by Polacoat, Inc. This and other similar materials permit excellent projection from the rear without loss of projection effect of light from the front.

Booth Construction Materials—These booths can be constructed from various combinations of materials; no specific guidelines are given. The figures demonstrate a basic concept and are not intended to detail materials or dimensions.

Slides Reversed—All slides must be reversed in the projectors when using the rear projection method. This may decrease the quality of some slides but the overall method is highly acceptable.

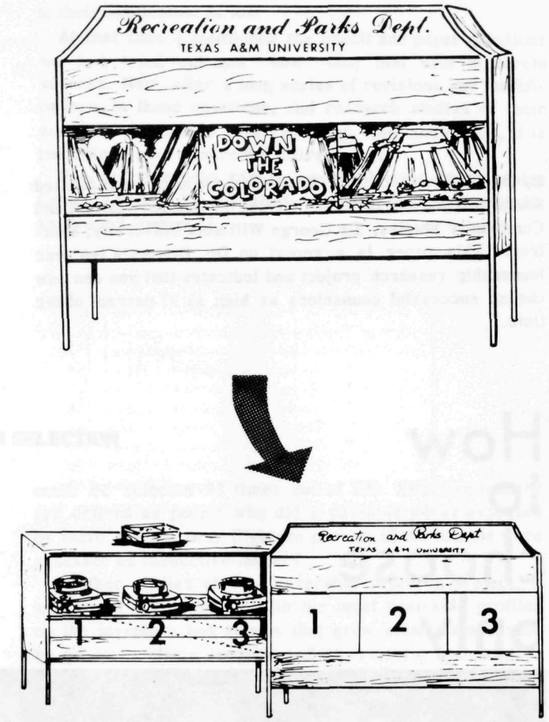


Fig. 11. A three—screen rear projection booth can be used to present many concepts in a professional method.

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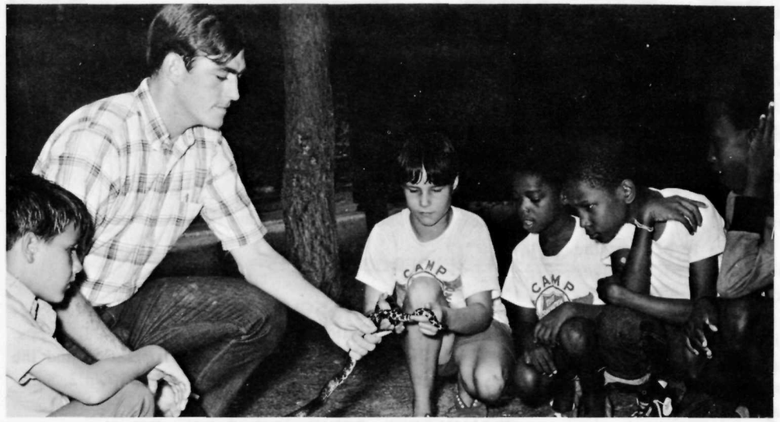
By Dr. Hedley G. Dimock, Chairman, Department of Applied Social Science and Director, Centre for Human Relations and Community Studies, Sir George Williams University, Montreal. This paper is a report on Dr. Dimock's ten year leadership research project and indicates that you can now choose successful counselors as high as 97 percent of the time.

How to choose only SUCCESSFUL CAMP COUNSELORS

Prince William Forest Park



A pencil and paper type leadership inventory has been developed that can be used in less than an hour. This inventory can predict who will be a successful camp counselor better than 9 times out of 10. It can be used to evaluate the effectiveness of pre-camp training programs or of a whole summer's training and supervisory program. In a general way, it can also be used to assess the extent to which there is, in a given camp, an educational climate that promotes growth of its participants.

Camp directors have often described the selection and training of staff as their most important job in camp. Certainly the character of the staff, the kind of behavior they model, and the way they work together with campers are the important determinants of the quality of campers' experience at camp.

The theoretical basis of this research has been the style of leadership available and the extent to which it encourages the participation of others. More detail on this can be found in the author's "Group Development," published in 1966 by Sir George Williams University.

"Those people who are affected by a decision should have a part in making that decision" has been a basic premise. In the past few years, acceptance of the whole concept of participatory democracy in universities and industry makes this theoretical basis now pretty matter-of-fact, but that was not the case in 1959 when I began my leadership research.

In my first report of this research, (Camping Magazine, December, 1961), I described a variety of approaches to making the camp application form a selection tool. No way was found in which an application form could be used to predict the success of staff who filled it out. This was an unpopular conclusion as most camps feel pretty attached to their application forms.

At that time I mentioned the pencil and paper questions we had tried out and how they met with moderate success. Now, after a long series of revisions and modifications in these questions, and research studies of their use in 8 situations with 200 camp staff and others, it is possible to give a more definitive report.

For the complete report, see "Selecting and Training Group Leaders," published in 1969 by the University as Project Report 13.

COUNSELOR SELECTION

The Dimock Leadership Inventory, published by Sheridan Psychological Services, Beverly Hills, California, consists of 82 questions answered on a 5-point scale indicating degree of agreement. Questions were selected to measure a flexible, cooperative, participative orientation to working with others. Typically, camp counselors completed the inventory in advance of their work; at the end of camp their supervisors and camp director evaluated their work. Correlations of the inventory with success as a group leader ranged from 23 to 69 percent in the different camps participating in the project. The accompanying diagram (Fig. 1) translates these stastics into functional terms.

This summary of 198 group leaders who worked in one of eight different situations shows that effective leaders can be selected 92 times out of 100 by not taking the 30% of applicants who scored lowest on the inventory. If the lowest 60 percent of applicants were rejected, effective leaders could be selected 97 times out of 100. Effective leaders are defined as people who did a passable job as assessed by their supervisors. Eighteen percent of the sample were assessed as ineffective leaders.

In other studies of this leadership research project, it was found that leaders with the most desirable profiles on the inventory had groups that grew most, as assessed by group members, leaders, and supervisors. And, leaders most highly rated by their supervisors grew most themselves.

Since the beginning of this project, 30 different educational or training groups have been studies in an attempt to identify the most effective leadership training programs. Groups studied have included university classes, human relations training laboratories and group guidance programs, in addition to several camp staffs.

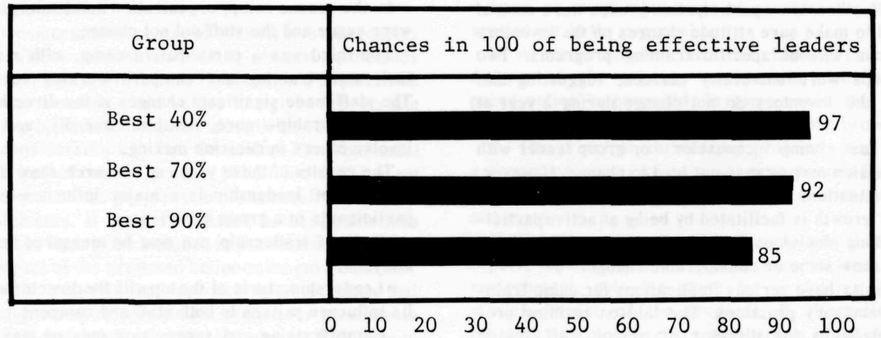


Fig. 1. Percentage of success of Dimock Leadership Interview in predicting group leader effectiveness.

LOW PARTICIPATION		MEDIUM PARTICIPATION	
0	Political Science Class	*	Kanawana Camp Supervision '60
0	Economics Class	**	Group Advisors Supervision
0	Rotary Camp Supervision	0	Group Supervisors Supervision
0	Inner City Youth Control	0	Program Workers Supervision
		*	Kanawana Camp Supervision '67
		*	Howell Camp Supervision
HIGH PARTICIPATION		**VERY HIGH PARTICIPATION**	
**	Group Development Class '61	**	Group Behavior Class
**	Group Development Class '62	**	Executive Training '62
*	Group Development Class '63	*	Executive Training '63
*	Group Development Class '64	**	Executive Training '64
**	Group Development Class '65		
*	Group Development Class '66		
*	Group Development Class '67	*	Nurses Training
*	Group Development Class '68	**	Sask. Human Relations Training
**	Group Development Class '69	*	Teen Human Relations Training
**	Sherbourne Camp Supervision	0	Sir George Human Relations Training
0	Inner City Youth Training	*	Rotary Training Lab.

0 = 0=no change *=some change **=considerable change

Fig. 2. Amount of learning under varying degrees of participation by groups taking part in Dimock Leadership Selection research program.

These 30 groups were all divided into four categories, depending on the degree to which the learners participated in the experience and the extent to which the learning was focused on their needs and interests. All groups were then rated in terms of the amount of change the learners showed on the Dimock Leadership Inventory—no change (0), some change (*) or considerable change (**). Considerable change was measured at the .01 level of confidence, suggesting a distinct movement to the profiles most frequently associated with successful group leadership. **Figure 2** shows the results.

Three of the low participation groups were control groups used to make sure attitude changes on the inventory did not occur without specific training programs. Two control groups were university classes, suggesting that profiles on the inventory do not change during a year at school.

Working as camp counselor or group leader with usual supervision may or may not lead to change. However, in the 21 situations that met the assumptions of this research —"growth is facilitated by being an active participant in making decisions which affect oneself"—all but two groups show some or considerable change.

These results have serious implications for camp training and supervisory practices. The laid-on training program organized by the director or senior staff, that is directed toward the tried and true programs of what "we do at our camp," are out of date. Developmental programs involving staff in working up content and freeing them to experiment with new programs reflecting their interests, are clearly ways to increase the competence of camp staff.

CAMP CLIMATE

During one phase of the research, the author studied three camps operated by the same organization for the same clientele. In the first camp most decisions were made by the director and senior staff. For example, the pre-camp training program was completely planned and scheduled several weeks in advance of camp. Staff of this camp changed their attitudes during the summer to reflect this orientation and became more dominating, prejudiced, rigid and unfriendly.

In the second camp, organization and leadership patterns were vague and the staff did not change.

The third was a participative camp, with staff planning their own training and campers working out programs. The staff made significant changes in the direction of effective leadership—more flexible, friendly and ready to involve others in decision making.

The results of these years of research show that:

- Style of leadership is a major influence on growth of participants in a group experience.
- Style of leadership can now be measured fairly accurately.
- Leadership starts at the top with the director and spreads its influence pattern to both staff and campers.

Camp training and supervision may or may not lead to personal growth. It depends on opportunities provided to become personally involved and responsible for having some say about what will happen during the summer at camp.

By Luna B. Leopold, Frank E. Clarke, Bruce B. Hanshaw, and James R. Balsley. **This report contains a procedure that may assist in developing uniform environmental impact statements. The heart of the system is a matrix which, along with a suggested method of use, is reprinted here from a draft, prepared in the form of a U.S. Geological Survey circular, a series used for tentative, incomplete or preliminary statements. It is subject to improvement, expansion, and change.**

A PROCEDURE FOR EVALUATING ENVIRONMENTAL IMPACT

In any proposal for construction or development, it is the usual practice, both from the standpoint of engineering and economics, to prepare an analysis of the need for the development and the relationship between its monetary costs and monetary benefits. More recently, society has recognized that in addition to these customary economic analyses and discussions of need, there should be a detailed assessment on the environment and thus its ecological, separate from its monetary, benefits and costs; put together, these assessments comprise an Environmental Impact Statement. The preparation of a Statement should be done by a team of physical and social scientists and engineers; likewise, reviews of statements will generally require an interdisciplinary team effort.

The Environmental Policy Act of 1969 directs all agencies of the Federal Government to "identify and develop methods and procedures which will insure that presently unquantified environmental amenities and values are given appropriate consideration in decision-making along with economic and technical considerations." The Council on Environmental Quality, in furtherance of Section 102 of the Act, has set forth guidelines for the preparation of the required environmental statements. It is recommended in these guidelines that the second item to be included in the statement is "the probable impact of the proposed action on the environment."

This article suggests an approach to accomplish that specific requirement by providing a system for the analysis and numerical weighting of probable impacts. This type of analysis does not produce an overall quantitative rating but portrays many value judgments. It can also serve as a guide in preparing the statement called for under Section 102 (2) (c) of the Act. A primary purpose is to insure that the impact of alternative actions is evaluated and considered in project planning.

DEVELOPMENT OF AN ACTION PROGRAM; GENERALIZED PROCEDURE

Evaluating the environmental impact of an action program or proposal is a late step in a series of events which can be outlined in the following manner. Figure 1 is a flow chart of the recommended sequence of events which results in an environmental impact statement. The sequence is discussed briefly below and that portion which deals with impact assessment is expanded in more detail later in the text:

A. A statement of the major objective sought by the proposed project.

B. The technologic possibilities of achieving the objective are analyzed.

C. One or more actions are proposed for achieving the stated objective. The alternative plans which were considered as practicable ways of reaching the objective are spelled out in the proposal.

D. A report which details the characteristics and conditions of the existing environment prior to the proposed action is prepared. In some cases, this report may be incorporated as part of the engineering proposal.

E. The principal engineering proposals are finalized as a report or series of separate reports, one for each plan. The plans ordinarily have analyses of monetary benefits and costs.

F. The proposed plan of action, usually the engineering report, together with the report characterizing the present environment, sets the stage for evaluating the environmental impact of the proposal. If alternative ways of reaching the objective are proposed in C and if alternative engineering plans are detailed in the engineering report, separate environmental impact analyses must deal with each alternative. If only one proposal is made in the engineering report, it is still necessary to evaluate environmental impacts.

The environmental impact analyses require the definition

of two aspects of each action which may have an impact on the environment. The first is the definition of the **magnitude** of the impact upon specific sectors of the environment. The term **magnitude** is used in the sense of degree, extensiveness, or scale. For example, highway development will alter or affect the existing drainage pattern and may thus have a large **magnitude** of impact on the drainage. The second is a weighting of the degree of **importance** (i.e. significance) of the particular action on the environmental factor in the specific instance under analysis. Thus the overall **importance** of impact of a highway on a particular drainage pattern may be small because the highway is very short or because it will not interfere significantly with the drainage. Depending upon the thoroughness and scope of the report inventorying existing environmental conditions, the analysis of **magnitude** of impact, though in some details subjective, can nevertheless be factual and unbiased. It should not include weights which express preference or bias.

The **importance** of each specific environmental impact must include consideration of the consequences of changing the particular condition on other factors in the environment. Again, the adequacy of the report under D would affect the objectivity in the assignment of the values for specific environmental conditions. Unlike **magnitude** of impact, which can be more readily evaluated on the basis of facts, evaluation of the **importance** of impact generally will be based on the value judgment of the evaluator. The numerical values of **magnitude** and **importance** of impact reflect the best estimates of pertinence of each action.

G. The text of the environmental impact report should be an assessment of the impacts of the separate actions which comprise the project upon various factors of the environment and thus provide justification for the determinations presented in F. Each plan of action should be analyzed independently.

H. The Environmental Impact Statement should conclude with a summation and recommendations. This section should discuss the relative merits of the various proposed actions and alternative engineering plans and explain the rationale behind the final choice of action and the plan for achieving the stated objective.

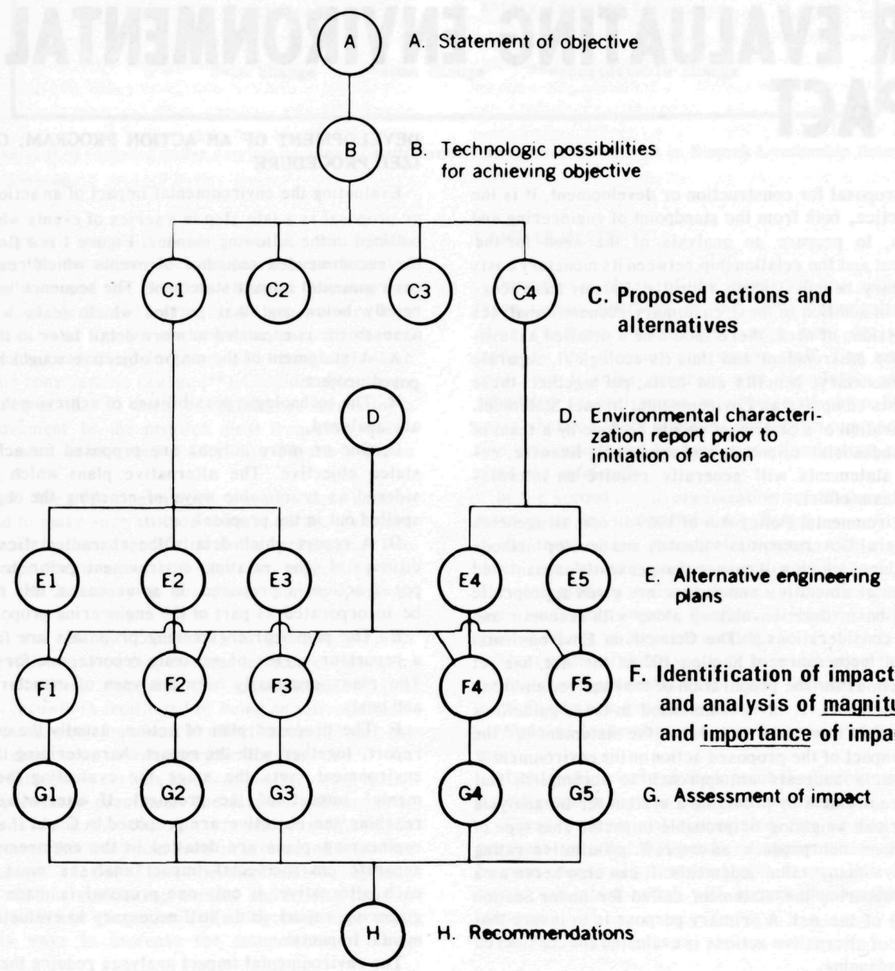


FIGURE 1.—Flow chart for development of action programs.

THE ENVIRONMENTAL IMPACT STATEMENT

A complete environmental impact statement consists of four basic items:

1. A complete analysis of the need for the proposed action. This would include parts A,B, and C of the Generalized Procedures;

2. An informative description of the environment to be involved, including a careful consideration of the boundaries of a project. For example, every drainage crossed by a highway can be affected at that point of crossing but may also be affected downstream as well owing to erosion. Therefore, these effects beyond the right-of-way should be described in part D of the Generalized Procedures;

3. A discussion of the pertinent details of the proposed action—part E of the Generalized Procedures;

4. An assessment of the probable impacts of the variety of specific aspects of the proposed action upon the variety of existing environmental elements and factors—parts F and G of the Generalized Procedures—and a summary or recommendation—part H—which would include the rationale supporting the selected plan of action.

The analysis of need, item (1) above, should be a justification which considers the full range of values to be derived, not simply the usual cost-benefit analysis. It should include a discussion of the overall objectives and of possible alternatives to meet them.

The characterization of the existing environment, item (2) above, should be a detailed description of the existing environmental elements and factors, with special emphasis on those rare or unique aspects, both good and bad, that might not be common to other similar areas. It should provide sufficient information to permit an objective evaluation of the environmental factors which could be affected by proposed actions. The description should include all the factors which together make up the ecosystem of the area. The vertical margin of the matrix (fig. x, y, z) can be used as a checklist in preparing this section.

The details of proposed action, item (3) above, should include discussion of possible alternative engineering methods or approaches to accomplish the proposed development (item 1.) This should be done in sufficient detail so that all actions that may have impact upon the environment (item 2) can be checked. The horizontal margin of the matrix can be used as a checklist in preparing this section.

The environmental impact assessment, item (4) above, should consist of three basic elements:

a. A listing of the effects on the environment which would be caused by the proposed development, and an estimate of the **magnitude** of each.

b. An evaluation of the **importance** of each of these effects.

c. The combining of **magnitude** and **importance** estimates in terms of a summary evaluation.

In preparing this article, it is not the intent to deal at length with items (1) through (3), and it is assumed that generalized procedures for their preparation are commonly followed since these items have been incorporated in many engineering feasibility studies and benefit-cost analyses of past projects. Rather, the primary intent is to focus on the new requirement and, therefore to address primarily the preparation of item (4)—the environmental impact assessment.

ENVIRONMENTAL IMPACT ASSESSMENT

Matrix

The analysis embodied in a, b, and c above is made with a matrix including on one axis the actions which cause environmental impact and on the other existing environmental conditions that might be affected. This provides a format for comprehensive review to remind the investigators of the variety of interactions that might be involved. It helps the planners to identify alternatives which might lessen impact. The number of actions listed horizontally in this sample matrix is 100 and the vertical list of environmental characteristics contains 88, which give a total of 8,800 possible interactions. Within such a matrix, only a few of the interactions would be likely to involve impacts of such **magnitude** and **importance** that they deserve comprehensive treatment. Although the items listed represent most of the basic actions and environmental factors likely to be involved in the full range of developments which require impact reporting, not all would apply to every project proposal. Even this large matrix may not contain all elements necessary to make a full analysis of every project proposal encountered. However, the coding and format are designed for easy expansion to include additional items. Preliminary trials suggest that the number of applicable interactions for a typical project analysis usually will be between 25 and 50.

The most efficient way to use the matrix is to check each action (top horizontal list) which is likely to be involved significantly in the proposed project. Generally, only about a dozen actions will be important. Each of the actions thus checked is evaluated in terms of **magnitude** of effect on environmental characteristics on the vertical axis, and a slash is placed diagonally from upper right to lower left across each block which represents significant interaction. In marking the matrix, it is important to remember that actions may have major short-term impact (for a year or so) which are ameliorated in a few years and thus of minor or negligible importance in a long time frame. Conversely, other actions with lesser initial impact may produce more significant and persistent secondary effects and, therefore, have major impact in a long time frame. In the text, which discusses the matrix, one should indicate whether he is assessing short-term or long-term impact. As an example, oil drilling rigs are commonly considered noisy and nonaesthetic but they are on location for short periods of time—generally one to six months per site, whereas untreated spoil banks may silt and acidify streams for many years after completion of a project.

In marking the boxes, unnecessary replication can be avoided by concentrating on first-order effects of specific actions. For example, "mineral processing" would not be marked as affecting "aquatic life", even if the waste products are toxic in aquatic environments. The aquatic impact would be covered under "emplacement of tailing," "spills and leaks," or other processing operations which may lead to degradation of aquatic habitat.

After all the boxes which represent possible impact have been marked with a diagonal line, the most important ones are evaluated individually. Within each box representing a significant interaction between an action and an environmental factor, place a number from 1 to 10 in the upper left-hand corner to indicate the relative **magnitude** of impact; 10 represents the greatest magnitude and 1, the

INFORMATION MATRIX FOR ENVIRONMENTAL IMPACT ASSESSMENT

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

II PROPOSED ACTIONS WHICH MAY CAUSE ENVIRONMENTAL IMPACT

INSTRUCTIONS

1- Identify all actions (located across the top of the matrix) that are part of the proposed project.
2- Under each of the proposed actions, place a slash at the intersection with each item on the side of the matrix if an impact is possible.
3- Having completed the matrix, in the upper left-hand corner of each box with a slash, place a number from 1 to 10 which indicates the MAGNITUDE of the possible impact; 10 represents the greatest magnitude of impact and 1, the least, (no zeroes). Before each number place + if the impact would be beneficial. In the lower right-hand corner of the box place a number from 1 to 10 which indicates the IMPORTANCE of the possible impact (e. g. regional vs. local); 10 represents the greatest importance and 1, the least (no zeroes).
4- The text which accompanies the matrix should be a discussion of the significant impacts, those columns and rows with large numbers of boxes marked and individual boxes with the larger numbers.

SAMPLE MATRIX

	a	b	c	d	e
a		2/1			8/5
b		7/2	8/8	3/1	9/7

		A. MODIFICATION OF REGIME															B. LAND TRANSFORM.							
		a. Exotic flora or fauna introduction	b. Biological controls	c. Modification of habitat	d. Alteration of ground cover	e. Alteration of ground water hydrology	f. Alteration of drainage	g. River control and flow modification	h. Canalization	i. Irrigation	j. Weather modification	k. Burning	l. Surface or paving	m. Noise and vibration	a. Urbanization	b. Industrial sites and buildings	c. Airports	d. Highways and bridges	e. Roads and trails	f. Railroads	g. Cables and lifts	h. Transmission lines, pipelines and corridors
PROPOSED ACTIONS																								
I EXISTING CHARACTERISTICS AND CONDITIONS OF THE ENVIRONMENT — A. PHYSICAL AND CHEMICAL CHARACTERISTICS — 1. EARTH	a. Mineral resources																							
	b. Construction material																							
	c. Soils																							
	d. Land form																							
	e. Force fields and background radiation																							
	f. Unique physical features																							
2. WATER	a. Surface																							
	b. Ocean																							
	c. Underground																							
	d. Quality																							
	e. Temperature																							
	f. Recharge																							
	g. Snow, ice, and permafrost																							
3. ATMOSPHERE	a. Quality (gases, particulates)																							
	b. Climate (micro, macro)																							
	c. Temperature																							
4. PROCESSES	a. Floods																							
	b. Erosion																							
	c. Deposition (sedimentation, precipitation)																							
	d. Solution																							
	e. Sorption (ion exchange, complexing)																							
	f. Compaction and settling																							
	g. Stability (slides, slumps)																							
	h. Stress-strain (earthquake)																							
	i. Air movements																							
ICAL CONDITIONS — 1. FLORA	a. Trees																							
	b. Shrubs																							
	c. Grass																							
	d. Crops																							
	e. Microflora																							
	f. Aquatic plants																							
	g. Endangered species																							
	h. Barriers																							
	i. Corridors																							
	a. Birds																							

Figure X

I EXISTING CHARACTERISTICS AND — B. BIOLOGI	2. FAUNA	b. Land animals including reptiles	
		c. Fish and shellfish	
		d. Benthic organisms	
		e. Insects	
		f. Microfauna	
		g. Endangered species	
		h. Barriers	
		i. Corridors	
C. CULTURAL FACTORS	1. LAND USE	a. Wilderness and open spaces	
		b. Wetlands	
		c. Forestry	
		d. Grazing	
		e. Agriculture	
		f. Residential	
		g. Commercial	
		h. Industrial	
		i. Mining and quarrying	
	2. RECREATION	a. Hunting	
		b. Fishing	
		c. Boating	
		d. Swimming	
		e. Camping and hiking	
		f. Picnicking	
		g. Resorts	
	3. AESTHETICS AND HUMAN INTEREST	a. Scenic views and vistas	
		b. Wilderness qualities	
		c. Open space qualities	
		d. Landscape design	
		e. Unique physical features	
		f. Parks and reserves	
		g. Monuments	
		h. Rare and unique species or ecosystems	
		i. Historical or archaeological sites and objects	
		j. Presence of misfits	
	4. CULTURAL STATUS	a. Cultural patterns (life style)	
		b. Health and safety	
		c. Employment	
		d. Population density	
	5. MAN-MADE FACILITIES AND ACTIVITIES	a. Structures	
		b. Transportation network (movement, access)	
		c. Utility networks	
		d. Waste disposal	
		e. Barriers	
		f. Corridors	
D. ECOLOGICAL RELATIONSHIPS SUCH AS:		a. Salinization of water resources	
		b. Eutrophication	
		c. Disease-insect vectors	
		d. Food chains	
		e. Salinization of surficial material	
		f. Brush encroachment	
		g. Other	
OTHERS		a.	
		b.	

COMPUTATIONS		

Figure Y

II PROPOSED ACTIONS WHICH MAY CAUSE ENVIRONMENTAL IMPACT

CIRCULAR 645
PLATE 1

A. MODIFICATION OF REGIME	B. LAND TRANSFORMATION AND CONSTRUCTION	C. RESOURCE EXTRACTION	D. PROCESSING
a. Exotic flora or fauna introduction	a. Urbanization	a. Blasting and drilling	a. Farming
b. Biological controls	b. Industrial sites and buildings	b. Surface excavation	b. Ranching and grazing
c. Modification of habitat	c. Airports	c. Subsurface excavation and retorting	c. Feed lots
d. Alteration of ground cover	d. Highways and bridges	d. Well drilling and fluid removal	d. Dairying
e. Alteration of ground water hydrology	e. Roads and trails	e. Dredging	e. Energy generation
f. Alteration of drainage	f. Railroads	f. Clear cutting and other lumbering	f. Mineral processing
g. River control and flow modification	g. Cables and lifts	g. Commercial fishing and hunting	g. Metallurgical industry
h. Canalization	h. Transmission lines, pipelines and corridors		h. Chemical industry
i. Irrigation	i. Barriers including fencing		i. Textile industry
j. Weather modification	j. Channel dredging and straightening		j. Automobile and aircraft
k. Burning	k. Channel revetments		k. Oil refining
l. Surface or paving	l. Canals		l. Food
m. Noise and vibration	m. Dams and impoundments		m. Lumbering
	n. Piers, seawalls, marinas, and sea terminals		
	o. Offshore structures		
	p. Recreational structures		
	q. Blasting and drilling		
	r. Cut and fill		
	s. Tunnels and underground structures		

	E. LAND ALTERATION	F. RESOURCE RENEWAL	G. CHANGES IN TRAFFIC	H. WASTE EMPLACEMENT AND TREATMENT	I. CHEMICAL TREATMENT	J. ACCIDENTS	OTHERS	COMPUTATIONS
	n. Pulp and paper	a. Reforestation	a. Railway	a. Ocean dumping	a. Fertilization	a. Explosions	a.	
	o. Product storage	b. Wildlife stocking and management	b. Automobile	b. Landfill	b. Chemical deicing of highways, etc.	b. Spills and leaks	b.	
	a. Erosion control and terracing	c. Ground water recharge	c. Trucking	c. Emplacement of tailings, spoil and overburden	c. Chemical stabilization of soil	c. Operational failure		
	b. Mine sealing and waste control	d. Fertilization application	d. Shipping	d. Underground storage	d. Weed control			
	c. Strip mining rehabilitation	e. Waste recycling	e. Aircraft	e. Junk disposal	e. Insect control (pesticides)			
	d. Landscaping		f. River and canal traffic	f. Oil well flooding				
	e. Harbor dredging		g. Pleasure boating	g. Deep well emplacement				
	f. Marsh fill and drainage		h. Trails	h. Cooling water discharge				
			i. Cables and lifts	i. Municipal waste discharge including spray irrigation				
			j. Communication	j. Liquid effluent discharge				
			k. Pipeline	k. Stabilization and oxidation ponds				
				l. Septic tanks, commercial and domestic				
				m. Stack and exhaust emission				
				n. Spent lubricants				

Small quantities of this chart are available upon request from Distribution Section, U.S. Geological Survey, 1200 South Eads Street, Arlington, Virginia 22202

Figure Z

least. In the lower right-hand corner of the box, place a number from 1 to 10 to indicate the relative **importance** of the impact; again 10 is the greatest.

As an example, assume that a particular engineering proposal recommends construction of highways and bridges. The proposed action is item II.B.d. on the matrix. "Highways and bridges" might have environmental impacts through effect on "erosion" and related "deposition and sedimentation", among other things. "Erosion" and "deposition-sedimentation" occur under the main heading "Physical and Chemical Characteristics of the Environment" on the left side (ordinate) of the matrix and in the horizontal rows I.A.4.b. and I.A.4.c., respectively.

In this example, it might be that bridges will cause an important amount of bank erosion, because geologic materials in the area are poorly consolidated. This may lead the investigator to mark the **magnitude** of impact of highways and bridges on erosion 6 or more. If, however, the streams involved already have high sediment loads without objectionable secondary effects, the effective **importance** of bridges through increased erosion and sedimentation might be considered relatively small and marked 1 or 2 in the lower righthand corner of the block. This would mean that while **magnitude** of impact is relatively high, the **importance** of impact is not great.

In the assessment of accidents (II, J) such as "spills and leaks", it would be desirable to have some guide which would be helpful in determining the probability and effect of accidents. In this matter, the inclusion of controls which would reduce the probability of an accident would lower the matrix entry of **magnitude**, but it would have no influence on the evaluation of **importance** of impact.

The next step is to evaluate the numbers which have been placed in the slashed boxes. At this point, it is convenient to construct a simplified or reduced matrix which consists of only those actions and environmental characteristics which have been identified as interacting. Special note may be taken of boxes with exceptionally high individual numbers, as by circling the box. Although not used in this article, we have found it convenient, when comparing alternatives in an action program, to identify the beneficial and possibly detrimental impacts. However, in most cases the preparer will consider all impacts to be potentially deleterious because all the plus factors would have been covered in the engineering report. Other investigators may wish to devise their own numerical rating methods; hence, the marginal boxes of Plate I are simply titled "computations".

It must be emphasized that no two boxes on any one matrix are precisely equatable. Rather, the significance of high or low numbers for any one box only indicates the degree of impact one type of action may have on one part of the environment. If alternative actions are under consideration and a separate matrix is prepared for each action, identical boxes in the two matrices will provide a numerical comparison of the environmental impact for the alternatives considered.

Assignment of numerical weights to the **magnitude** and **importance** of impacts should be, to the extent possible, based on factual data rather than preference. Thus, the use of a rating scheme such as the one suggested here discourages purely subjective opinion and requires the author of an environmental impact statement to attempt to quantify his judgment of probable impacts. The overall rating allows the reviewers to follow the originators' line of reasoning and will aid in identifying points of agreement and disagreement. The matrix is, in fact, the abstract for the text of the environmental assessment.

Text

The text of an environmental impact assessment should be a discussion of individual boxes marked with the larger numerical values for **magnitude** and **importance.** Additionally, those columns which cause a large number of actions to be marked, regardless of their numerical values, should be discussed in detail. Likewise, those elements of the environment (rows) which have relatively large numbers of boxes marked should be addressed. The discussion of these items should cover the following points as put forth in the Council on Environmental Quality's guidelines published in the Federal Register (1971):

(i) a description of the proposed action including information and technical data adequate to permit careful assessment of impact (this has been covered as items C and E in fig. 1).

(ii) the probable impact of the proposed action on the environment

(iii) any probable adverse environmental effects which cannot be avoided

(iv) alternatives to the proposed action

(v) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity

(vi) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented, and

(vii) where appropriate, a discussion of problems and objections raised by other Federal, State, and local agencies and by private organizations and individuals in the review process and the disposition of the issues involved. This section may be added at the end of the review process in the final text of the environmental statement.

All of these points itemized above can be covered as part of a discussion of the matrix.

The text that accompanies the completed matrix should be primarily a discussion of the reasoning behind the assignment of numerical values for the **magnitude** of impact effects and their relative **importance.** The text should include a discussion of those actions which have significant impact and should not be diluted by discussions of obviously trivial side issues.

To be fully understandable, the discussion of the **magnitude** and **importance** of applicable impacts and responses will require some discussion in the text of the principal characteristics, physical and ecological, of the environment itself and some of the important characteristics of the proposed action which govern its environmental impact. The environmental impact assessment thus relies on and refers to the data incorporated in items 1, 2, and 3 (p.3)—the full description of the geography, physical setting, vegetation, climate, and other facts about the environment and the physical and engineering aspects of the proposed development. This explanation is inserted here to caution that the environmental impact assessment need not be burdened nor should it be padded with descriptions of the

project and the environment per se. It should include only such details as are needed for evaluating the environmental impact. The completed environmental impact assessment, together with items (1), (2), and (3), comprises the finished Environmental Impact Statement; all four items are required for review purposes.

In order to test the usefulness of the matrix approach, a matrix for an actual proposed mineral extraction and processing operation has been prepared and included as an appendix. This example is solely a model used for demonstration purposes and is not intended to be an impact assessment of the example project. A brief synopsis of the justification, regional setting, and general plan of operation extracted from a report which covers items (1), (2), and (3) of an environmental impact statement is included. In addition, for each of the boxes with entries, there is a brief discussion of the impact rating including the reasoning behind the assignment of values.

CONCLUDING STATEMENT

Obviously, the wide variety of projects and actions have such differing impact on environmental factors that no scheme of impact assessment will be universally applicable. However, greatest need is not for a single and universally applicable assessment method, but rather for a simple way of summarizing which impacts are considered of greatest moment by the people making the assessment. Different assessors will seldom come to identical conclusions, but it would be useful to know the basis for the difference.

The advantage of a matrix is in its use as a checklist or reminder of the full range of actions and impacts. The proposed manner of using the matrix is aimed at separating as far as possible factual information on **magnitude** of each type impact from the more subjective evaluation of the **importance** of the impact, the latter involving preference or bias to some degree. This separation of fact from preference is highly desirable.

APPENDIX

Impact Assessment of a Phosphate Mining Lease by Matrix Analysis

A phosphate deposit estimated to include 80 million tons of crude ore of an average content of 8.7 percent P_2O_5 is located in Los Padres National Forest, Ventura County, California. The ore consists of sand-size pellets of phosphorite occurring in a sequence of sandstones and siltstones of late Miocene age. The beds crop out on hillslopes along a strike length of about five miles. The beds dip approximately 30 degrees north. The mineable beds are 90 feet thick with an overburden varying from 0 to 200 feet.

Application for a prospecting permit was made in February 1964, and a permit was granted in November 1964. A three-year extension of the permit was approved in October 1966. The company made an application for a Preference Right Phosphate Lease in April 1969. The background material needed for the present analysis is contained in the company's report. Parts of the report are abstracted below for purposes of this article.

The regional environment. The deposit occurs in a semiarid region receiving 23 inches of annual percipitation, most of which occurs in the period November through April. The principal drainage system in the area is Sespe Creek; its headwaters are about five miles west of the Lease Application. In its upper reaches, Sespe is an ephemeral stream. The proposed mining operation would be two miles north of the Sespe. Vegetation ranges from sparse to medium heavy, is of a chaparral type including oak, manzanita, and mountain mahogany, and with a low density ground cover of grass.

Access to the area is by means of California State Highway 33, a black-topped paved road which runs from Ventura to Bakersfield. The prospect is within one to two miles of this highway; present access is over a temporary unpaved road. To develop the property, about one and a half miles of permanent paved road would have to be built.

The region is sparsely settled. In a five-mile radius of the proposed mine, there are six year-round residents plus ten summer residences. The nearest towns are Meiners Oaks and Ojai, 25 miles to the south, and New Cuyama about 35 miles to the north.

General mining plans. The ore crops out as a narrow band about five miles long. Test core drilling indicated that the rock is too unstable to support underground workings and the company proposes to develop the mine by open-pit methods. The strike is approximately perpendicular to the local stream channels which drain toward Sespe Creek. The small canyons cut across the ore zone every 2,000 to 3,000 feet along the strike. In order to prevent damage to the watershed, the company envisions a mining operation which would not dam or interrupt these channels. Therefore, over the life of the mining operation a series of open pits would be dug parallel to the strike and terminated short of the tributary valleys which cross the ore body. The dimensions of the proposed open pits will be determined by the interval between adjacent canyons. Pit width would be a function of the amount of overburden which could be removed economically. In the downdip direction, mining would extend only so far as economics of overburden removal would allow.

The planned open pit geometry is V-shaped. One limb would follow the foot wall of the ore zone at approximately 30 degrees from the horizontal. The high wall would be cut at 45 degrees to the horizontal. Such a pit would be worked in a series of 20-foot high benches running parallel to the strike.

Ore processing. An ore-processing plant would be constructed at the mine site to crush the ore. After crushing, the phosphate would be leached out with acid. The resultant pregnant liquor would be neutralized with quicklime to precipitate dicalcium phosphate in a granular form.

The tailings from the leach process is quartz sand which would be washed, dewatered, and stored in the open pit areas where mining had been completed.

The phosphate in the form either of granular solids or liquid would be transported to market via trucks. The major raw materials required to be brought in are quicklime and sulphur, the latter being converted to sulphuric acid at the mine site. Water required for the processing is small and is to be supplied by a 1,000-foot deep well already drilled.

Watershed and environmental values. There are two principal environmental values which require consideration in this area as well as many subsidiary ones. A primary consideration is the effect on the California condor, a rare and endangered species present in the general region. The second major consideration is location of the mine lease close to the center of a large block of National Forest land. Pertinent to the latter is the fact that the total lease, 2,434 acres, is small by comparison with the total Forest. The site is 15 miles east-southeast along the mountain ridge from the edge of the San Rafael Wilderness so that no designated wilderness lands are involved. However, the need for recreational use of undeveloped public lands in California to relieve population pressure is relatively great and any commercial operation in an undeveloped area would have an effect on such use.

The Sespe Condor Sanctuary, located in the National Forest, lies 15 miles to the east of the mining area. From the sanctuary, the condors are said to range along the crestline to the northwest, across the center of the whole National Forest area. The ordinary flight or soaring patterns for condors would pass through the general region of the proposed mine site. One condor nest, apparently now abandoned, has been noted a few miles west of the mining site. The other known condor nests all lie within the condor sanctuary.

Among the subsidiary environmental impacts which the mining operation might cause, a few are mentioned briefly below and are discussed in more detail in connection with the impact matrix.

The possibility of water pollution from the phosphate itself is minimized by the fact that the phosphate ore is quite insoluble as shown by water quality analyses on surface water in the area. The mining operation would not increase the soluble phosphate content of the water resource. The effectiveness of erosion control measure applied within the mining area will determine the quantity of particulate phosphate mineral and other sediments added to Sespe Creek. The liquid chemicals handled at the plant are to be confined within dikes. Except for possible leakage from these dikes, or in case of spills on the highway, water pollution from processing chemicals and products should not occur.

Increased soil erosion and related sediment load to stream channels will depend upon the manner in which the stream channels crossing the ore body are protected from the open-pit mining operation.

Some level of air pollution is possible from noxious gases emanating from the plant in the form of fluorine from the ore, SO_2 gas from the manufacture of sulphuric acid, and fuel combustion products. Blasting, drilling, and equipment noise will have some environmental impact. Mining equipment will be diesel-powered and controlled by conventional mufflers.

The power requirements of the plant are estimated to be 5,000 KVA. The mine would require the construction of 14 miles of transmission lines which are to be erected on wooden poles on the right-of-way of State Highway 33. Natural gas would be taken from a pipeline already in the area which passes within three miles of the proposed plant site using either overhead or buried lines.

The impact on vegetation and wildlife is influenced by the fact that, over the life of the mine, only 400 acres will be subjected to actual mining. The mining operation would involve an annual excavation of four to five acres with reclamation following closely in the mined-out area. A total of about 40 acres thus would be disturbed at any given time.

The brief summary above shows the main aspects of the planned mining operation for which environmental impact is being evaluated. More details on these and other aspects of the area and the project plan are contained in the company's report.

Using material contained in the company's report, an information matrix analysis was completed in the manner described in the previous section. The outcome of the analysis is recapitulated in reduced form as figure 2. The explanations which follow indicate the reasoning followed in this example.

The mining plan calls for a small "alternation of drainage" so that effects on "erosion" and "sedimentation" should be minor as compared with the effect of "highways and bridges" and "emplacement of tailings." "Modification of habitat" and "alteration of ground cover" are not likely to be important impacts because the total mined area is relatively small. "Industrial buildings" and "construction of highways" are considered to be among the more important impacts. The "blasting and drilling" under "construction" (II.B.q.) will be short term and have limited impact, but "drilling and blasting" for "resource extraction" (II.C.a.) will continue sporadically over the life of the project and, therefore, is relatively important. "Surface excavation" and "mineral processing" appear to have relatively important impact potential. On detailed consideration, "product storage" and "erosion control" are viewed as less important than some of the construction and resource extraction items noted above. Changes in traffic owing to the increase in "trucking" rather than increase in "automobile traffic" is considered to be capable of producing important impact. The "emplacement of tailings" would occur throughout the life of the project and could have significant effects if poorly controlled. "Liquid effluent discharge" would be small during all phases of the project, and, therefore, would be relatively unimportant by comparison. "Spills and leaks" owing to accidents could be important within the mining operation area depending on the effectiveness of diking. Accidents would be especially significant on the highways over which new materials and finished products must be hauled.

With such consideration, the number of proposed actions considered important enough for discussion was reduced to nine. Under each of these items in the vertical column existing characteristics and conditions of the environment were inspected individually. Where the interaction was deemed sufficiently important, the impact was numerically evaluated in terms of **magnitude** and **importance.** The resulting codification appears in the completed matrix (fig. 2). The types of impact are discussed below in order of the items listed on the left-hand side of figure 2.

Water quality (I.A.2.d.). Water quality could be affected by the "surface excavation," by "emplacement of tailings," and by the possibility of "accidental spills and leaks." The planned "surface excavation" is off-channel and was, therefore, assigned **magnitude** 2. Because of the ephemeral nature of the streams, the **importance** of the excavation in affecting water quality was rated 2 also.

			Industrial sites and buildings II B. b.	Highways and bridges II B. d.	Transmission lines II B. h.	Blasting and drilling II C. a.	Surface excavation II C. b.	Mineral processing II D. f.	Trucking II G. c.	Emplacement of tailings II H. c.	Spills and leaks II J. b.
I	A. 2. d.	Water quality					2/2	1/1		2/2	1/4
I	A. 3. a.	Atmospheric quality						2/3			
I	A. 4. b.	Erosion		2/2			1/1			2/2	
I	A. 4. c.	Deposition, Sedimentation		2/2			2/2			2/2	
I	B. 1. b.	Shrubs					1/1				
I	B. 1. c.	Grasses					1/1				
I	B. 1. f.	Aquatic Plants					2/2			2/3	1/4
I	B. 2. c.	Fish					2/2			2/2	1/4
I	C. 2. e.	Camping and hiking					2/4				
I	C. 3. a.	Scenic views and vistas	2/3	2/1	2/3		3/3		2/1	3/3	
I	C. 3. b.	Wilderness qualities	4/4	4/4	2/2	1/1	3/3	2/5	3/5	3/5	
I	C. 3. h.	Rare and unique species		2/5		5/10	2/4	5/10	5/10		
I	C. 4. b.	Health and safety							3/3		

FIGURE 2.—The reduced matrix for a phosphate mining lease.

The same reasoning applies to the "emplacement of tailings" which are off-channel and not of a noxious character. "Spills and leaks" were considered sufficiently rare to be assigned **magnitude** 1, but if they occurred, they would be moderately **important** and, therefore, given a value of 4.

In actual practice, any of the identified impacts can be expanded to produce secondary matrices which can cover greater detail than is possible on plate I or figure 2 if the analysts or reviewer feels the need to do so. As an example, expanding the matrix items related to "water quality," the relative **magnitude** and **importance** of different specific actions may be more clearly shown than by merely using the main headings in the matrix. The example (fig. 3) indicates how expansion may show details pertinent to the individual situation. Additionally, water quality could also be expanded into subcategories such as pH, dissolved oxygen, turbidity, etc.

Atmospheric quality (I.A.3.a.). "Mineral processing" would be the principal source of degradation in atmospheric quality. Its **magnitude** was rated 2 owing to the small size of the plant and the absence of other industrial operations. Its **importance**, however, was rated 3 because of the sulphuric nature of the gases produced.

Erosion (I.A.4.b.) and deposition (I.A.4.c.). Some "erosion" and thus some channel "deposition" will be caused by the construction of "highways and bridges" and by the "emplacement of tailings." The sandy nature of the washes in the area and thus naturally high sediment loads give both "erosion" and "deposition" caused by the project a relatively low importance. The **magnitude** and **importance** of each were relatively low owing to the fact that the mining operation would involve the construction of less than two miles of new roads and that protection against erosion is included in the design of the mining operation.

Shrubs (I.B.1.b.) and grasses (I.B.1.c.). The disturbances of native "shrubs" and "grasses" is important only on the area which is going to be physically disturbed by the mining. Because vegetation change would occur only on parts of the 2,434 acre lease over the life of the project and revegetation is part of the scheduled project, the **magnitude** and **importance** are both rated low.

Aquatic plants (I.B.1.f.).—"Aquatic plants" do not occur in the ephemeral streams near the plant site but do occur in the portion of the main stream some miles down valley where Sespe Creek is perennial. Any effect on "aquatic plants" reaching that far downstream would come from "excavation" and from "emplacement of tailings." The distance to the perennial stream indicated low values for **magnitude**, but a moderate value for **importance** in the case of "spills."

Fish (I.B.2.c.).—The same reasoning that governed the assessment of impact on "aquatic plants" applies also to "fish" which persists only some miles downstream where Sespe Creek is perennial and the probable impacts are rated low.

Camping and Hiking (I.C.2.e.). The only alteration involving "camping and hiking" is caused by "surface excavation." Owing to the small area to be affected, its **magnitude** is rated 2, but its **importance** was considered moderate and rated 4 because any environmental change that interrupts recreational use of public land in a highly populated State is relatively important.

Scenic Views and Vistas (II.C.3.a.).—This is one of the characteristics that is most seriously impacted by the proposed development. "Scenic views" are impaired in quality owing to "industrial buildings," "highways and bridges," "transmission lines," "surface excavation," "trucking," and "empacement of tailings." All these have a low to moderate value of **magnitude** and generally a somewhat higher figure for **importance.** Compared with any of the previous items, the actions impacting "scenic views and vistas" are more numerous.

Wilderness qualities (I.C.3.b.). The item "wilderness and open space" (I.B.1.a.) as a land use is not important in this area because it is not designated wilderness; accordingly, it was not rated. What is important is the aesthetic and human interest item—"wilderness qualities." Thus, a distinction is made between wilderness as a "land use," not important in this area, and the "quality" of wild land which is considered highly important in the area. "Wilderness qualities" would be impacted under the proposed project primarily by "industrial buildings," "highways and bridges," "surface excavation," "trucking," and "emplacement of tailings." The impact of each on "wilderness qualities" is rated moderate with respect to both **magnitude** and **importance.** The result of this is that the degradation of "wilderness qualities" may be considered a potentially important impact caused by the proposed development.

Rare and unique species (I.C.3.h.).—Possibly the most important environmental impact of the proposed development is its potential effect on the condor. A distinction is made between the biological conditions of fauna, "endangered species" (I.B.2.g.), and the item under "aesthetics and human interest," "rare and unique species." The condor could be covered under either of these two, but should not be under both. As a matter of choice then, the condor problem is specified under the item of "aesthetics and human interest."

	Industrial sites and buildings				High-ways and bridges		Trans-mission lines		Surface excav-ation			Mineral proc-essing		Trucking	Emplace-ment of tailings			Spills and leaks			
	Waste water	Sewage	Washing	Runoff from paving	Runoff during construction	Runoff from finished road	Sediment from cleared zone	Construction sediment	Sediment from fill	Effects of ore exposures	Effects of deep seepage	Sulfuric acid use	Acidity of yard runoff	Spilled sulfur compounds	Erosion of fill	Deep seepage	Acidity of seepage	Highway truck spills	Tailings pond leak	Tailings dams washout	Plant spills of acid
Water quality	3/3	3/3	1/1	1/2	1/1	1/2	1/1	1/1	2/2	1/1	1/1	1/1	1/3	1/4	3/3	1/2	1/2	1/3	1/3	1/1	1/1

FIGURE 3.—Expanded matrix showing actions which would impact water quality.

Consideration was given to the fact that the main nesting area for the condors is some miles to the southeast and that a Naval training camp involving much heavy equipment is already operating near that nesting area. It is believed that the effect of the proposed development on condors would come about primarily from the "blasting" and from the increase in "truck traffic." For both of these actions, the **magnitude** is considered moderate and rated 5, but the **importance** of the survival of condors was considered to be great and thus any impact is of high importance. Those two items were, therefore, given an **importance** score of 10. Also the sulphur fumes from "mineral processing" might be an important deterrent to the use of this part of the range by condors. The effect on the birds is unknown, but it is conceivable that air pollution would keep them from landing to catch prey wherever the smell and smoke occurred. The **magnitude** of impact of this action was assessed as 5 and **importance** as 10.

Health and safety (I.C.4.b.). "Health and safety" would be impacted primarily by the increase in "trucking" on the highway as a result of mine operation.

Summary. Inspection of figure 2 immediately gives the essence of the matrix analysis: the proposed actions which have most environmental impacts are the construction of "highways and bridges," the "blasting," "surface excavation," "mineral processing," "trucking," and the "emplacement of tailings." The environmental characteristics most frequently impacted are those of "scenic views and vista," "wilderness qualities," and "rare and unique species."

As an outcome of this matrix analysis, the reviewers could ask the petitioners for the phosphate project "What actions can you take to reduce these possible impacts to lower levels?" if the impact is deemed sufficiently great. As an example, assume that the company, in light of the comparative values shown in the simplified matrix, decided to substitute for daytime trucking, a night-time only schedule for moving supplies and products. If it was known that condors soar only during the day and would be unaffected by night-time traffic, that **magnitude-importance** impact might be significantly reduced. Assume also that as another step to reduce impact, the company decided to mat the ground surface prior to any rock blasting. If this step were deemed effective, matrix entry of 5/10 of blasting on rare and unique species might perhaps reduce the entry at 1/10. These changes may, in one sense, appear to be minor, but in fact would cause a significant reduction in impact on the specific environmental factor shown to be most affected.

REFERENCES

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Contributed by Conrad R. Lickel, Director of the Bureau of State Parks, Pennsylvania Department of Forests and Waters. "Demand Methodology" was used in Pennsylvania's statewide plan for outdoor recreation. The formula determines the acreage required to provide recreational opportunities for an estimated visitation. The plan has been approved by the Bureau of Outdoor Recreation. Other states may find it useful in justifying proposals for land acquisition.

DEMAND METHODOLOGY

Those who attempt to measure recreation demand are restricted largely to empirical methods, since there is a relative lack of knowledge and statistics concerning the subject.

Research to date has been mostly based upon park visitation records and limited polls and surveys conducted in various places. From this limited information, estimates have been made defining quantitative outdoor recreation demands for the present and future. Unfortunately, there has been little effort to formulate a qualitative definition of demand.

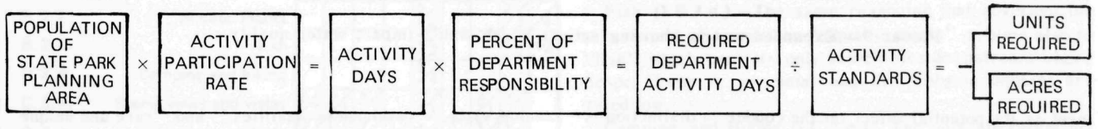
A desire to "go camping" can be readily expressed and dutifully recorded and the camping demand projected on the basis of this registered wish. However, the type of camping experience desired is more difficult to determine.

Quality of outdoor recreation experiences varies with the individual. The recreationist's personal relationship with an outdoor environment varies from one which is solitary, appreciative and inspirational to one which is little more than utilitarian.

Thus, the lack of qualitatively oriented research upon which to base demand methodology decisions results in a very real danger. Too often, emphasis has been placed upon quantitative considerations to the detriment of quality recreation experiences. This danger is increasingly apparent as open space becomes less available and recreation pressures increase at existing facilities.

Faced with a lack of scientifically determined guidelines or methodology, the recreation planner is forced to proceed with demand calculations in a flexible fashion. He avoids becoming unwarrantedly specific but, at the same time, shies away from unproved generalizations. A methodology needs to be developed that incorporates, not only research and statistical information, but also the invaluable practical experience gained by park personnel and administrators. It should also be flexible enough to reflect the inherent dynamic nature of outdoor recreation, with its constantly evolving trends and changing demands.

With these aims in mind and recognizing the inadequacy of the present level of outdoor recreation research, a demand methodology was formulated for this plan. It is diagramatically expressed as follows:



Using this formula, it was possible to compute the estimated number of recreation units which are considered to be the responsibility of the Pennsylvania Department of Forests and Waters. This total was then further translated into acreage requirements by applying space standards and buffer requirements.

A detailed discussion of the various components of this formula follows.

ACTIVITY DAYS

The concept of "activity day" has come to be widely accepted as a means of expressing individual recreation participation. It can be defined as a measure of recreation-use by one person on one facility or area for the duration of one day, or for a part of a day. A recreationist that swims in the morning and picnics in the afternoon has expended two activity days of recreation—one day picnicking and one day swimming.

The Pennsylvania State Planning Board employed the firm of Hammer, Greene, Siler Associates to estimate the recreation demand, as expressed in activity days, for the summer season of 13 weeks from June 1 to August 31 for the years 1976, 1980, 1985, and the year 2000.* This was accomplished for each of the 19 outdoor recreation activities listed in the Outdoor Recreation Resources Review Commissions' report to the President and Congress. This was further refined to reflect not only the total activity days for the entire State, but also for each of the 13 State Planning Board Regions.

The activity-day totals were computed by multiplying the estimated population by the applicable ORRRC activity participation rates. These rates reflect the number of days an average person participates in a given outdoor recreation activity during the 13 week summer season. The computed totals were then further modified to reflect the influence of certain important socio-economic considerations.

*Winter and fall season used when applicable

The activity-day totals, as presented by Hammer, Greene, Siler Associates, were refined to include the segment of the population 12 years old or less. (These individuals were not included in the above mentioned report.)

These adjusted totals were then redistributed to reflect the eight State Park Planning Areas.

The activity-day totals for the 13-week summer season were used in this report in order to intelligently plan for the summer recreation demand load. The Department of Forests and Waters records indicate that 70% of all Pennsylvania State Park recreation activity takes place during the summer season.

DEPARTMENT RESPONSIBILITY

The proposed responsibility of this agency was determined by considering the existing recreation facilities being provided by the Department of Forests and Waters in relation to the total calculated activity-day demand. With the assistance and experienced judgment of the planning staff of the Bureau of State Parks, based on available information, the proposed responsibility for each of the recreation activities was then set.

The Bureau of Outdoor Recreation requires a review of the State Park master plan every five years. Thus, the percentages of responsibility can be modified at any of these periodic reviews to reflect the current thinking of the Department.

ACTIVITY STANDARDS

The total responsibility of the Department of Forests and Waters expressed in activity-days for each State Park Planning Area was obtained by multiplying the percent of responsibility times the number of demand activity-days for that area. Activity standards were then applied to activity-days totals to yield (1) the total required developed acreage, and (2) the necessary number of recreational units to satisfy the demand for a particular activity. The derivation of activity standards is based on park planning guidelines from numerous agencies, particularly the Department.

Activity standards as used for the calculations are expressed as either (1) the number of activity days per developed acre (Area Standards) or (2) the number of activity days per unit (Unit Standards).

These two factors were developed according to the following formula:

> Number of units per acre x number of people per unit x turnover factor x number of recreation days per week x number of recreation weeks in summer season equals (1) number of activity days per developed acre ÷ by number of units per acre equals (2) number of activity days per unit.

NUMBER OF SITES PER ACRE

This is the number of recreation facilities for a given activity (i.e. campsites) which can be placed on an acre of park land. This number is based on experience and varies with the desired density.

NUMBER OF PEOPLE/SITE

This respresents the number of people normally associated with one activity facility or site (i.e. camping equals 4, picnicking equals 4.5).

TURNOVER FACTOR

The number of times the given facility or site is utilitized per day (i.e. picnicking equals 1-1/2).

NUMBER OF RECREATION DAYS/WEEKS

This number represents the average total weekly use of a recreation facility divided by the design capacity of that facility. It is based on park records and observations of park personnel. It has been generally set at 2-1/2 days for all activities except camping, which is expressed as 3 days.

NUMBER OF WEEKS/RECREATION SEASON

The Outdoor Recreation Resources Review Commission has defined the outdoor recreation summer season as the 13 weeks extending through the months of June, July, and August.

For other sports, such as hunting, skiing and ice skating, the appropriate peak 13 week season was used.

The product of the five factors above expresses the total 13-week summer seasonal use in activity-days on a developed acre of park land devoted to a given recreation activity Area Standard. If this amount is divided by the number of units per acre, the number of activity days per unit is obtained (Unit Standard).

By dividing the total number of activity days that the Department is responsible for, by Area Standards, the total number of developed acres, by activities, is obtained. This can then be converted to gross park acreage by adding the necessary acreage for support facilities such as roads and sewage disposal plants and that number of undeveloped acres required as a recreation buffer. If the same activity-day total is divided by Unit Standards, the total number of units required to satisfy this activity-day demand will be obtained.

The demand calculations described above are based on the resident population of Pennsylvania. The calculations do not take into account visiting recreationists from outside Pennsylvania or the number of Pennsylvania residents who travel to adjacent states for outdoor recreation.

Recreation statisticians and planners are constantly faced with the problem of estimating the ebb and flow of mobile recreationists across municipal, county and state borders. This phenomenon is observed throughout the Commonwealth and is present to varying degrees in all State Parks. Its magnitude is dependent upon such factors as available recreation supply, the recreation resource attractibility, accessibility and population pressures. The constant expansion of urbanized areas, with the resulting disappearance of open-space, enhances the attractiveness of once distant recreation areas. Population growth has increased this trickle of migrating recreationists to flood proporations in some areas.

Park records reflect this increasing mobility and indicates that approximately 12% of all visits are made by out-of-state residents. However, there is little factual information concerning the number of Pennsylvania recreationists who visit facilities of other states.

A recent study of the recreation activities and preference of people living in the region of the Delaware River Basin indicates that at least 40% of the residents of the Philadelphia area seeking outdoor recreation leave Pennsylvania. Very little is known about the recreation outflow (leaving Pennsylvania) from other sections of the State. The assumption is therefore made that, with the exception of the Philadelphia area, the flow of recreationists out of Pennsylvania equals the flow of out-of-state recreationists into the Commonwealth.

The recreation inflow and outflow between State Park Planning areas is also difficult to define quantitatively. This interaction and migration between planning areas has not been statistically evaluated as yet. However, information is being gathered on a park by park basis. This information, when expanded, will provide a statistical base from which such an analysis can be made.

As indicated above, it has been determined that 40% of the outdoor recreationists of the Philadelphia area go to other states. This figure seems quite reasonable when Philadelphia's proximity to the recreation resources of the Atlantic Coast is considered. For this reason the demand calculations for this area were reduced to reflect this outflow.

However, because of the inability at this time to quantify the recreation inflow and outflow of the remaining seven State Park Planning areas, the demand calculations for these are based solely on resident populations.