SYSTEM FLEXIBILITY

Packaging Research to Meet Each Viewpoint

The overall system can be segmented in various ways to make complete scientific packages that answer a wide range of objectives, depending on the type of decision-maker involved. We may package scientific work along functional research lines; for example, a complete package for water-quality research. We may package scientific work along engineering lines; for example, a complete package for residential developments. We may package scientific work along service lines; for example, a complete package for water-supply and waste-disposal policies.

Traditionally, our research has been organized into discrete scientific fields or disciplines that can be pigeonholed according to parts of the system flow outlined in the environmental-effect viewpoint. The objective of such research has been to dig deeply within a narrow field of study. The environmental-effect viewpoint stresses this objective. It suggests research possibilities within a narrow segment of the total system and enables us to:

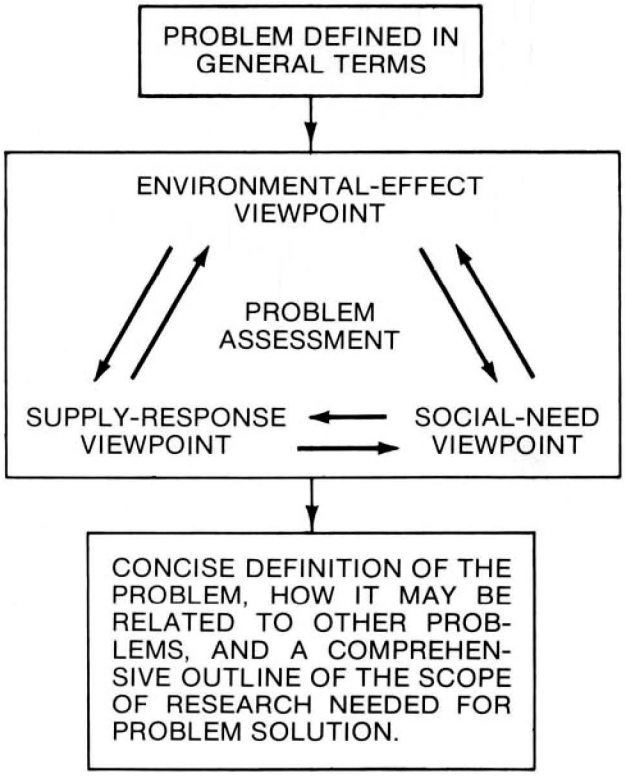
1. Evaluate a research study proposal in the context of the total needs within a specific functional or scientific area.
2. Develop a research program in a functional area that will provide input information to the social-needs and supply-response systems.

By bringing the social-need and supply-response viewpoints to bear on a given environmental problem, we can evaluate that problem from the position of the decision-maker who is responsible for providing associated social needs or technological developments. Faced with a contemplated development project or program, for example, decision-makers themselves can begin to evaluate resulting environmental effects by looking at the system from their own point of view. Such examinations can provide:

1. An appraisal of the technology involved.
2. An outline of the research required to measure the primary and secondary effect of such technology on natural ecosystems.
3. A relevant outline for preparing an environmental impact statement concerning that same technology.
4. An improved understanding of environmental systems.
5. Knowledge required to permit more effective efforts to prevent environmental degradation.
6. A means through research to accommodate man's activities to environmental constraints.

From their own viewpoints of the system, decision-makers can define the research information input they need. Then, by referring to the environmental-effect viewpoint of the system, these same decision-makers can evaluate a research proposal or suggest what kind of research is needed in terms of their own immediate requirements.

Thus we can generate and reinforce the information required to comprehensively attack a given problem when that problem is subjected to all three viewpoints in this way:

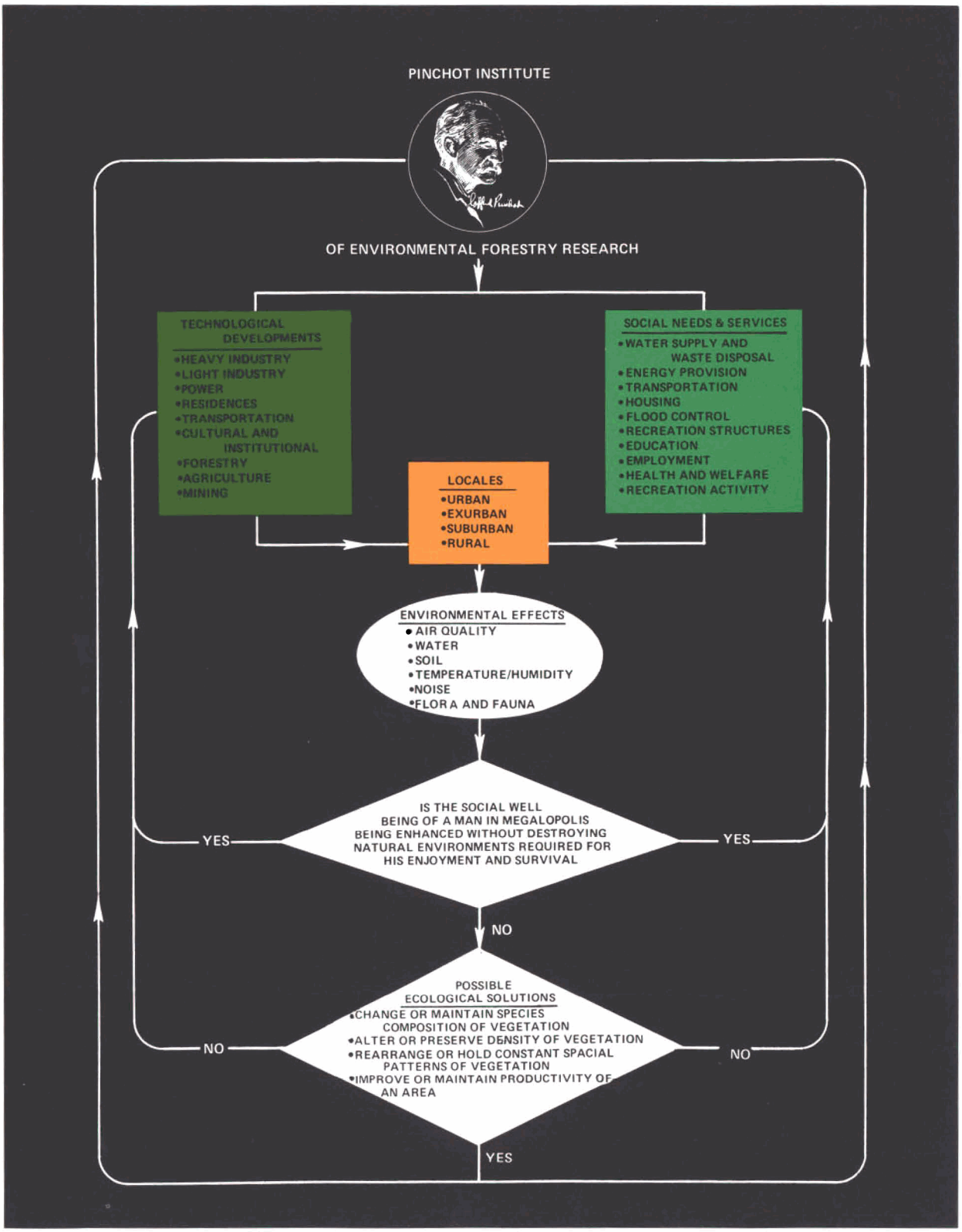


However, in the final analysis of any given problem, the effects of the social and supply innovations will be determined not by the extent to which man can manipulate the external world but by the limitations of the ecosystem (or environmental-effect viewpoint). The ecosystem constraints set the sideboards for the ultimate solution to any given problem. Only in this way will the research approach provide answers that insure the proper functioning of natural ecosystem required for man's ultimate survival in and around Megalopolis.

Who, What, Where, When, Why, and How?

The six questions (who? what? where? when? why? and how?) about research are often difficult to answer explicitly. This system, however packaged, should make answering them easier. The environmental-effects and services components taken together broadly answer the question *what*. The development and locale segments taken together broadly answer *where*. Answers to these two questions go a long way toward determing *how* to conduct the research, although much of the *how* sometimes must (and should) be left to the researcher's ingenuity. Use of the system to indicate relevant combinations shows *why* the work is important. We already know the scientist is going to do the work, and the research administrator says *when*.

A DIAGRAM OF THE ENTIRE SYSTEM



HOW THE SYSTEM WORKS

An Environmental-Effect Approach

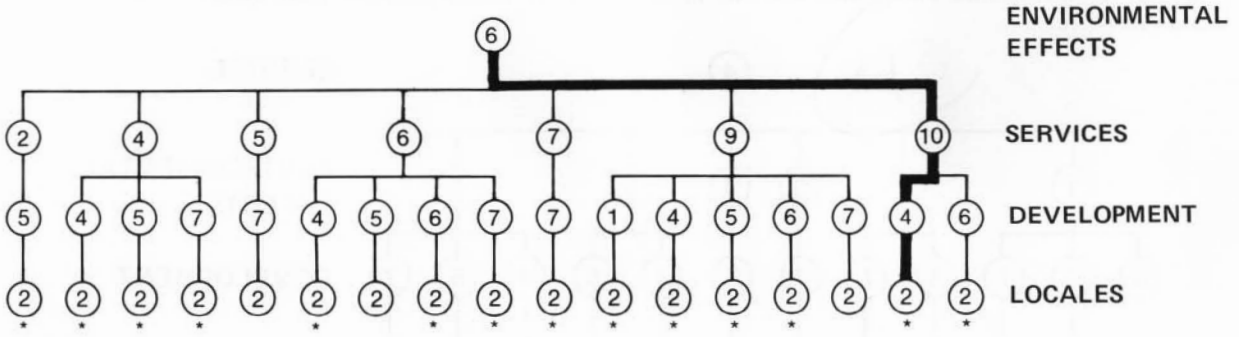
Use of the packages will be illustrated by example, and in this example our primary package will be formulated from the environmental-effect viewpoint. We begin by assuming that a specific research proposal is made to a research administrator, and we trace the administrator's evaluation of the proposal with reference to the complete catalogue of studies in the general area of interest for a specific environmental effect. (The example is kept very simple here simply to illustrate the procedure.)

> *A scientist proposes studying vegetation manipulation in housing developments in suburban areas so that the results of his research can be used where residents can enjoy certain songbirds and wild animals in suburbia. (Songbirds, incidentally, are also an extremely important factor in natural ecosystems related to man's health and wellbeing.)*

Wildlife habitat (flora-fauna) is the central issue here, so we go first to the environmental-effect viewpoint figures, select figure 23 (flora and fauna), and code the research proposal as 6-10-4-2:

Environmental Effect	*Service*	*Development*	*Locale*
(flora-fauna)	(recreation activity)	(residences)	(suburban)
6	10	4	2

To place the research proposal in perspective, we chart all other flora and fauna effects in figure 23 that are relevant to suburbia (locale 2). We examine the interconnected parts of figure 23 that are relevant to the environmental effect stipulated in the proposed study. Those parts of that system are:



The number in each circle follows the numbering code for effects, services, developments, and locales found in table 1. An asterisk along the bottom line of numbers indicates a high-priority package. The original proposal in the flow chart is indicated by a heavy line. All other possibilities are shown by light lines.

By evaluating the research proposal in this way, we begin to see how it relates to a complete research program for flora and fauna effects in a suburban setting. By inspection, conclusions can be reached on several important points regarding how the study is related to overall Pinchot Institute objectives:

1. It is in a high-priority package category.
2. It is part of a group of 17 relevant packages or study areas—of which 14 are high-priority packages.
3. Seven suburban services are involved in the total subsystem—services 2, 4, 5, 6, 7, 9, and 10 (table 1).
4. Five developments in suburbs are involved in the total subsystem—developments 1, 4, 5, 6, and 7 (table 1).

For evaluation of a study proposal by a research administrator—and depending upon the ability, qualifications, and experience of the

scientist—one of several recommendations is likely:

1. The proposal is accepted and funded.
2. The proposal is expanded to include other services, such as 4, 6, and 9 as well as 10.
3. The proposal is included in a larger study designed to encompass all 17 relevant study areas.

Recommendation 3 is tantamount to a program-development charge; the research administrator has made a program-development analysis from the flow chart and indicates what to include and where to do it. The first step in program evaluation is taken.

Next, a senior scientist should make an analysis of the problems within the program to determine what information is already known and what needs further research.

A Social-Need Approach

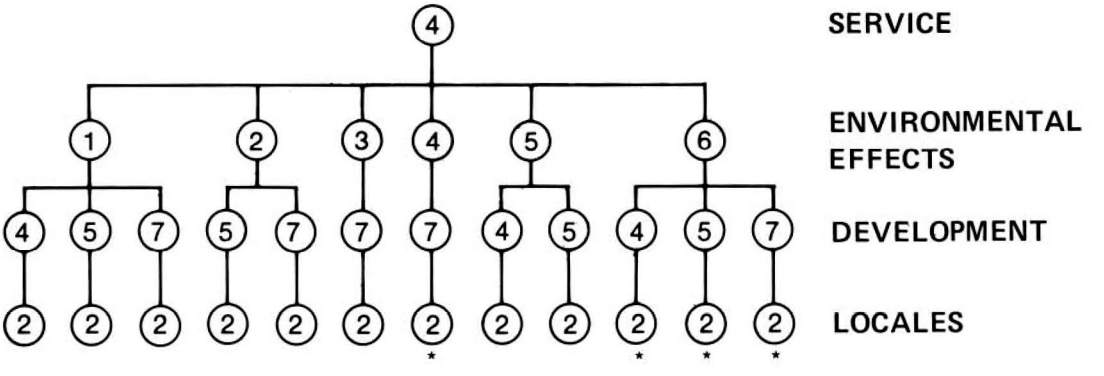
Now consider a research problem from the social-need response viewpoint. For example, a research question from this perspective could be:

> *In the course of legislating housing needs (service 4) for suburban areas (locale 2), what environmental effects will we encounter that may be ameliorated or protected through policies and programs governing vegetation management? What form of environmental forestry research is needed to develop relevant information for developing policy to regulate housing?*

The package code at this point has only two numbers, one for services and one for locales:

Services (housing)	*Effects*	*Developments*	*Locales* (suburban)
4	?	?	2

The missing parts of the package must be supplied to develop a research program. In figure 3, social need number 4 (housing) is selected and traced through the paths (or subsystem) where the two codes (4 and 2) exist. Those parts of that system are:



The number in each circle follows the number system for services effects, developments, and locales found in table 1. An asterisk along the bottom line of numbers indicates a high-priority package.

Therefore, by filling in the missing code numbers so that all the relations can be traced, development of the program proposal for housing in suburbia has begun. Now we can recognize what environmental factors are relevant in this context and what developments they are related to:

1. Research capability in all six environmental categories in this program must be developed.
2. Only three developmental-viewpoint situations are likely to be encountered:
   a. Residence (4) under three environmental effects areas.
   b. Transportation (5) under four environmental effects areas.
   c. Forestry (7) under six environmental effects areas.

3. About one-third of the indicated study areas are high priority.

Thus, as in the previous example, the problem dimensions are defined and the relative complexity is determined—clear avenues to problem selections and analysis. The research administrator interested in addressing the enhanced problem package has a point of beginning for determining the expertise and funding needed.

A Supply-Response Approach

In a traditional sense, the importance one should attach to evaluating a given problem in the above manner depends upon the responsibilities of the one making the appraisal. A suburban real-estate developer, using the previous example, has an outline on which to base an environmental impact statement, or on which to make an engineering evaluation of technical alternatives.

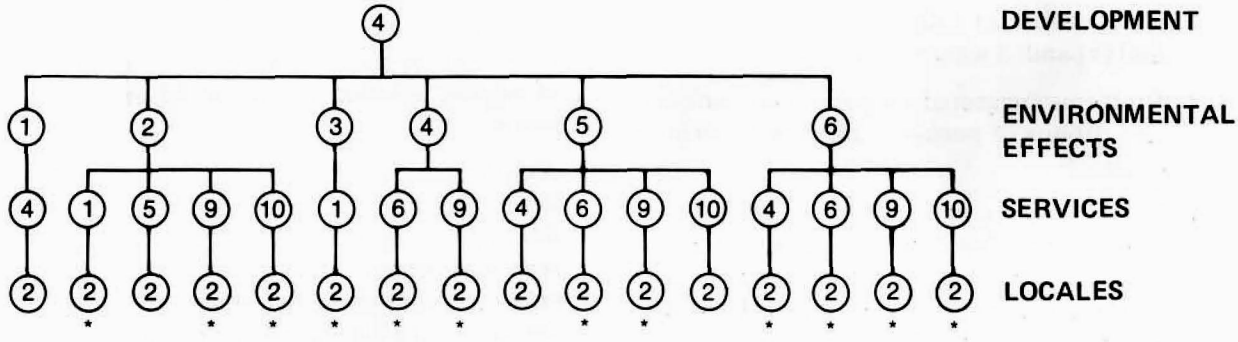
However, the developer—using the supply-response viewpoint—may ask the research question somewhat differently:

> *In the course of building suburban residences (locale 2, development 4), what effects will such development have on natural systems of the environment that can be enhanced, protected, or avoided through manipulation of vegetative composition, density, patterns, or productivity?*

Here the package code is:

Developments (residences)	*Effects*	*Services*	*Locales* (suburban)
4	?	?	2

The missing parts of the package can be supplied by referring to figure 12 (residences) and tracing through the paths (or subsystem) where the two codes (4 and 2) exist. Those parts of the system are:



The number in each circle follows the number system for services, effects, developments and locales found in table 1. An asterisk along the bottom line of numbers indicates a high-priority package.

We conclude from this flow that:

1. Capabilities in all six environmental categories are required.

2. Six social services are also interrelated with residences:
   a. Water supply and waste disposal (1) under two environmental effects.
   b. Housing (4) under three environmental effects.
   c. Transportation (5) under one environmental effect.
   d. Recreational structures (6) under three environmental effects.
   e. Health and welfare (9) under four environmental effects.
   f. Recreational activity (10) under three environmental effects.

3. Three-quarters of the indicated study areas have high priority.

Advantage of Using All Three Viewpoints

A research administrator, using the previous example of how the system works, has an outline to help him evaluate a research proposal or to develop a research program. The research administrator also sees that the wildlife-habitat research program described in the example about an environmental-effect viewpoint could constitute work in 20 to 25 percent of the suburban planner's environmental problems that are amenable to vegetation management. Both the suburban developer and the policy-maker understand their roles in the total research picture.

Decision-makers from all three viewpoints now have broader based views, and they should be able to communicate their needs and problems with one another much more quickly and surely.

Thus the reinforcing feedback loop of information mentioned earlier for all three viewpoints becomes readily apparent in the total system.

RESEARCH PLANS TO ENHANCE THE SYSTEM

Recognized Weaknesses

The Pinchot Institute recognizes at least nine aspects of this first-generation system for exploratory research and problem evaluation that need improvement:

1. Components in table 1 need to be revised and expanded where necessary.
2. Problems suggested by individual packages and groups of packages need to be defined explicitly.
3. Where answers to parts of problems already exist, results should be published in concise, compact form for use by decision-makers. In this same regard, a continuous literature review is required to update and publish supplements to the initial reports.
4. Dependent and independent variables in each problem, or associated problems, need to be clarified.
5. Parallel and interconnecting links among and within the major components of the system need to be explored in preliminary pilot research studies.
6. Preliminary research studies are needed to adequately assess the need for concentrated research at given points or interconnecting sections of the system.
7. With the exception of a somewhat gross attempt to set priorities, a weighting procedure needs to be developed within the total system for allocating limited research funds and manpower.
8. As the system becomes more complex, retrieval computer procedures will need to be developed that will allow a given management problem to be defined from all three viewpoints and to print out either the location within the Consortium where the expertise exists to solve the problem or the references in the literature where the total or partial solution to the problem can be found.
9. As information about the total Pinchot Institute system becomes available, multidisciplinary teams need to model the research-allocation system for a variety of environmental problems. Such an approach should eventually provide an optimum combination of packages that could be funded according to an expected payoff matrix of results.

Multidisciplinary Team Approach

Multidisciplinary research teams have been established within the Pinchot Institute's Consortium of universities and inhouse research units to attack the nine basic weaknesses mentioned above. With the capability to utilize the expertise of many disciplines that exist throughout its nine leading institutions, the Institute's Consortium can create almost any type of multidisciplinary team that may be required to solve environmental forestry problems throughout Megalopolis. The Consortium has the physical plant capabilties to comprehensively and quickly engage in research to

answer the ecological-oriented problems of metropolitan planners and developers.

Starting with a given viewpoint, each team examines groups of research packages within various parts of the total system. Examples of elements to be considered by teams using each viewpoint have been listed previously in the descriptions of those three viewpoints. When a team is satisfied that it has considered most of the important dependent and independent variables of interest, the framework for writing a problem analysis and for developing individual research studies becomes fairly straightforward.