

The Indiana Biological Survey: An Unending Synthesis

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Introduction

Every year more people become increasingly aware of the high level of interaction and dependence between human activity and the quality of our environment, particularly its living component. This awareness is increasing because plants and animals growing in more or less natural communities satisfy many physical and mental requirements of our lives. But such awareness also is due to a growing moral maturity which includes not only concern for the human species or consideration of primates or other animal species, but also a moral responsibility towards plants and of the general environment itself. Questions traceable to this widening moral awakening have revealed an embarrassing and critical gap in our knowledge of animal and plant species, and of the environments in which they are found. Even more surprisingly, this lack of information is even acute for rare species, which in some ways should be easier to study. We are in the difficult position of knowing what we should do in terms of moral decision-making, but we are unable to act due to lack of sufficient and reliable information!

This paper provides insights into what is being done in Indiana to assemble past information on the State's biota, to make useful summaries of these data available quickly and economically, to point out important gaps in our knowledge, and to increase awareness in all citizens of our natural heritage. These are the tasks of the Indiana Biological Survey. We hope that its approaches and methodologies also can serve as a model for the organization of similar long term surveys in other states. Such studies by their nature and duration, must involve many people and many institutions.

History of the Indiana Biological Survey

The Indiana Biological Survey (IBS) is the main activity of the Biological Survey Committee (BSC), a standing committee of the Indiana Academy of Sciences. The BSC chairman (currently Crovello) and other committee members are appointed by the Academy's President. Formed in 1892, the BSC is almost as old as the Indiana Academy itself. As stated in the 1893 Proceedings of the Academy, its original purpose was, ". . . 1) to ascertain what has already been accomplished in the direction of making known the character and extent of the life of the State, and to this end to prepare a complete bibliography of materials bearing on the botany, zoology and palentology of Indiana, to be published by the Academy; 2) to associate the various workers throughout the State and so correlate their labors that all will work together towards a definite end, and ultimately accomplish the main purpose of the survey, namely, the making known of the entire fauna and flora of Indiana, its extent, its distribution, its biological relations, and its economic importance; 3) to stimulate the teachers of

biology throughout the State to encourage in their pupils the accumulation of material, which shall make known the local extent and distribution of life forms, and thus contribute facts that will be useful in the survey and at the same time develop acute observers for continuing the study of the natural resources of the State; 4) ultimately to secure for the academy a collection that will illustrate the biology of the State.”

Even though several people (Deam, 1940; Lindsey, 1966; and Lindsey et al, 1969) actively studied and surveyed the State’s biota, over the last several decades BSC activity was confined to an annual survey of the literature.

As indicated above, a growing need for diverse and detailed information on the biota of the State is apparent. However, potential users of such information, no longer restricted to academic biologists, now include such diverse people as preparers of environmental impact statements, employees of State and federal agencies, teachers at all levels, area and regional planners, and individuals with various private interests. More importantly, federal legislation (e.g., the Endangered Species Act of 1973) now requires developers to demonstrate that their activity will not endanger certain species. This and other legislation require a basic, detailed knowledge of the biota of Indiana. It is essential that such knowledge be accumulated, that subsections of it relevant to a specific task be made available in a useful way, and that citizens of the State become aware of their valuable heritage.

As a first step in this direction, in 1974 Crovello proposed to the Academy: “That a formal Flora Indiana Project be created whose major purpose will be the continued maintenance and dissemination of information about the kind, quantity and distribution of the plant life of the State. The information accumulated would be maintained and disseminated in ways that are both useful and efficient.” The motion was adopted by the Academy in 1975 and subsequently formed the basis for an expanded revitalization of the BSC. The current goals of the BSC are the same as when the Academy was founded: to accumulate, store and make available in useful forms, information on the biota of the State.

Given the magnitude of the data base of interest, and the need for fast retrieval of selected pieces of it, we are using computers to help the BSC achieve its goals of accumulating and disseminating information. Since modern society created many of our environmental problems, it is fitting that the computer, an invention of modern society, should contribute to their solution.

Current Activities of the BSC

Given its purposes and building on the previous activities of the BSC in cataloging the literature of the State, (for which we must thank its past Chairman, Jack Munsee), the BSC is providing real or moral sponsorship to the following projects:

A. *BSC Literature Project*—Its purpose is to maintain and to accumulate information on published or semipublished references on the biota of the State, as well as works in progress. While in the past the BSC Literature Project has presented its findings in conventional printed form, we also have begun the

simultaneous creation of an cumulative computer data bank. It can provide updated, intergrated bibliographies of particular topics in response to specific requests. With support from the Academy and from Notre Dame, the following has been accomplished:

A1. I-LIT-OLD: A computerized file of ove 1500 references to the biota of Indiana, obtained by searching the pages of the Proceedings of the Indiana Academy between 1892 and 1976. While most references are from articles in the Proceedings, a number are from other sources that were referred to in the Proceedings. Information on each reference includes: author; date; title; citation; counties studied, (where easily obtainable); and type of article. Given the available resources, this computer file is incomplete. *Please* help us help Indiana by informing us of any omissions that you find. Simply use the latest reporting form, copies of which are available from the BSC.

A2. I-LIT-NEW: Beginning in 1977, an expanded Reporting Form is being used to assemble the recent literature AND works in progress about the biota of Indiana. Beginning with the 1978 literature, we will type completed forms into the computer and simultaneously create our computerized literature file *and* provide manuscript copy to the editor of the Proceedings, without expensive rekeystroking. Naturally, proofreading and error correction will have to be carried out on the computerized file before the computer prints out the manuscript copy. Much more information is being requested than in the past. But readers also will realize that this means they can request computer searches on this much more information. Thus, if one is interested in work on endangered species in Switzerland County, the computer will be able to answer that exact request.

As in the past, Reporting Forms continue to be sent to the chairpersons of the approximately 70 college and university life sciences departments in the State. They are requested to pass along copies of it to members of their departments who either have published on the State's biota or are engaged in research on it. This includes students as well as faculty. Beginning this year the BSC also is distributing Reporting Forms at the annual meeting of the Academy. But we still are not reaching everyone we should reach. *Please* provide the BSC with the name and address of any peson or organization that should receive Reporting Forms on a regular basis (e.g. state agencies, consulting firms).

B. *BSC Endangered Species Project*—Its purpose is to develop and maintain information on the status of species that might be threatened or endangered. Progress is being made in studying several large taxa, including mammals, fish and vascular plants. The BSC cooperates with John Bacone (Division of Nature Preserves, Department of Natural Resources) in the production of a list of rare and endangered vascular plants. Several Academy members (John Whittaker, H. E. McReynolds, and James Gammon) have completed a manuscript on rare vertebrates of the State. Finally, steps have been taken to assure maximum cooperation and mutual enhancement of the work of the BSC and Indiana's Natural Heritage Program. Additional collaborators are always welcome, but especially for nonvascular plants and invertebrates.

C. *BSC Flora Indiana Project (FLIP)*—Currently information is available on the presence or absence of each of approximately 2,500 vascular plants in each of Indiana's 92 counties. The BSC file is based on Deam's (1940) *Flora of Indiana*, plus 8,000 new records as verified by herbarium specimens, or found in recent works such as Swink (1974). This valuable computerized information is available as a byproduct of a Ph.D. thesis by Clifton Keller, a student of Crovello at Notre Dame. While these data deal only with plants, computer programs and other techniques also will be of use to a *Fauna Indiana Project*. Current services include the ability to provide a checklist of vascular plants in a given county (with rare species indicated as such). A *major* effort this year has been to update Deam's nomenclature. Many changes have occurred since the almost forty years when Deam's work was published. We have engaged the services of Doctor John Kartesz of Biota North America to help us. We also are exploring for the best way to integrate information from other sources (environmental impact statements, park checklists, etc.) into the FLIP data bank. Finally, there is need to produce a revision and expansion of Deam's (1940) *Flora of Indiana*. Persons interested in organizing or contributing to such a project should contact the BSC.

D. *BSC Indiana Vascular Plant Atlas Project*—Crovello and Keller are developing a manuscript for an *Atlas of the Vascular Plants of Indiana*. The final hard copy will look very much like the recent *Atlas of Illinois Plants* produced by Mohlenbrock. One difference is that we will produce camera ready copy of species level maps at a much cheaper rate by relying on special computer graphics facilities at Notre Dame. We hesitated to publish an *Atlas* at this time because it will be incomplete. But on the other hand, it will never be complete if we do not publish something to indicate the current status of our knowledge. Consequently, the *Atlas* will be based on information (at the county level) found in Deam's (1940) *Flora of Indiana*, *plus* the 8,000 new herbarium specimens which constitute new county records that were deposited at Indiana University, Bloomington, *plus* Swink's (1974) new information, *plus* possibly information from one or two environmental impact studies which amounted to a survey of the county in which it was located.

The *Atlas* will be produced as quickly and as cheaply as possible, to permit workers in the field to provide additions and other corrections. Different symbols will be used for each county record to indicate its source. Nomenclature will reflect changes since Deam, and at the same time be tied in with Deam's (1940) classic work.

E. *BSC Indiana Trees Project*—Mrs. Barbara Hellenthal and Crovello continue to work on a modification and expansion of Deam and Shaw's (1953) *Trees of Indiana*. This standard reference is out of print, but a more important reason for the current project is the need for a publication both to summarize current knowledge based on distributions in the past and to integrate it with knowledge of *present* distributions. Many workers, including impact assessment personnel, must know whether species are growing on a certain site in Indiana today, not whether they were there ten, twenty, forty, or more years ago. A detailed statement of purposes, possible contents of publications, *and* why and how citizens of the State (including students) should and could become involved

in a resurvey of the Trees of Indiana, was sent to all BSC members in December 1977. A copy of this December 1, 1977 statement, plus a request for opinions and help, was also sent in December 1977 to the State Forester. We believe that cooperation will be beneficial to the State, to the Division of Forestry, and to the goals of the Academy.

F. *BSC Indiana Environmental Impact Statements (I-EIS)*—We have begun discussions with several state and federal agencies on the possibility of creating a computerized file of detailed information on Indiana biota found in I-EIS's. Such data could be useful in many ways, including the updating of distribution records. Naturally, the source of such records would be retained, to permit users to estimate their relative reliability.

G. *BSC Indiana Vegetation Maps Project*—We are in the planning stages of a project to produce several different vegetation maps of Indiana. Each would be based on a different type of information. Given the goals of the Biological Survey Committee, including its function as an advisory group to state agencies as well as others, a map of the potential vegetation would be very valuable. In addition, currently under way are several projects to use satellite data to produce a *current* land use map of the State. Finally, via our Flora Indiana Project, a computerized table of county level presence or absence for 2500 species of vascular plants already exists. These three approaches need to be compared. We plan to request support for: a) the creation of a natural vegetation map *de novo*; b) the creation of vegetation maps based on species associations that are available at the county level, to see if information on vegetation associations can be obtained via the many intercorrelations that exist when one has data on 2500 species; and c) to compare these two with the latest land use map produced by satellite.

H. *BSC People Power Project*—This project maintains information on persons interested in any or all aspects of the biota of the State, including the accumulation and use of such data. People with interests in the biota of one geographic area immediately come to mind, as do people with interests in one taxon, one group of species, etc. But people of value to the goals of the BSC are not restricted to biologists. The expertise of geographers, geologists and archeologists to name a few, is of great value to the BSC.

Each Survey Project Is An Integrated, Multistage Process

While each project of the Indiana Biological Survey (IBS) can be described in discrete steps, compartmentalization of a more or less continuous process may be misleading (Crovello, 1970). Surveys are unending, multifaceted assessments of the changing state of dynamic natural and human ecosystems. Many of its different activities are carried out simultaneously. Nevertheless, for convenience we describe IBS operations in six stages: 1) planning ; 2) data accumulation 3) data bank deposition; 4) data bank maintenance; 5) data bank output; and 6) publicity. Each step is briefly outlined below.

Stage One: Planning

Planning has been effected mostly by BSC members, many of whom are not just academic biologists but also are active in groups such as The Nature

Conservancy and The Audubon Society. Interaction occurs also with workers and with other interested citizens throughout the State. Essential questions asked during the planning stage include: 1) what are current and future sources of support; 2) what types of data are required; 3) what types of users are expected; 4) what types of people are available to help; 5) what types of output are in demand now and will be in demand in the future.

Stage Two: Data Accumulation

Three substages of data accumulation exist: a) field work; b) subsequent specimen preparation, typed summaries, or publication; and c) data assembly. These substages are recognized because different people frequently are involved with each substage, each can be done at different times, and each involves different procedures. Field information can be stored in written notebooks, on photographic slides, as dried specimens, etc. The final substage, data assembly, frequently is overlooked. Yet it is both essential and time-consuming. Data assembly involves finding proper floras or faunas, the relevant museum specimens, etc., and then extracting from it the *specific* information required for a *particular* task.

Stage Three: Data Bank Deposition

Data bank deposition involves all activities which transfer information from museum specimens, publications, or data sheets into a computer bank. Some data banks are ecologically oriented, others concentrate on species, and others on specimens. So far most IBS data banks are species oriented at the county level. Each type provides different levels of resolution in response to taxonomic, geographic, or ecological questions about the State's biota.

Stage Four: Data Bank Maintenance

Too often in this age of the Computer Revolution we mistakenly think that once data are in a computer, users can obtain *any* type of desired analysis. The computer can only do what its programs have been instructed to do, and they can only operate on data that have been input and continuously updated to remain current. The computer is fast in retrieval, but many other tasks are associated with the creation and maintenance of a data bank about Indiana's biota. Two types of computer files are important. *Data files* contain the total body of information which, when properly searched and analyzed, provide answers to our questions. Such files must be kept current, which involves correction of information in the data bank, addition of new information, and subtraction of information of no use. The *program file* is the second type of computer file. New questions arise at a regular interval and new programs must be written to answer these new, usually more sophisticated questions.

Stage Five: Data Bank Output

The four major types of data bank output are: 1) prose printouts (or publication); 2) tabular results; 3) summary graphics; and 4) summary statistics.

Prose results requested from IBS include computerized printouts of a county checklist of all plant species, as well as county checklists for only rare plant species. Requests for such information come mostly from environmental impact statement workers and park naturalists. Monographers have received prose printouts summarizing the county level distribution of each species in the

family of interest. All such results were easily and cheaply obtained from the IBS computerized data bank. Prose results also are possible from the IBS Literature Bank. Details were provided in an earlier section of this paper.

Tabular results most requested frequently include information on the number of species per county as well as the number of species per family. The scope of tabular results, like Summary Graphics, is limited only by the creativity of the questioner.

Summary graphics may take several forms, the most common of which is the production of State distribution maps at the county level, usually one map for each species. Information from several sources is used to produce such maps. For example, users of distribution maps may want to know whether a county record for a given species is based on Deam's (1940) study, or a more recent one. This can be answered easily if the source of each county distribution record is stored in the computer. A species map at the county level can use one of several symbols to indicate a county record. For example, a D in a county may indicate that that county record was included in Deam. A number such as 73 could indicate that it was not reported in Deam, but that it was first collected in 1973. Finally, a compound such as D 73 might mean that for a specific county it was both recorded by Deam and the *latest* updated reverification was made in 1973.

A second form of graphic summary is the frequency of rare species by phytogeographic or political region. For example, rare plant data workers may be interested in knowing which counties have the highest number of rare plant species. A computer-assisted search of the entire data bank of information on 2,500 species can, in our case, identify those 485 species occurring in five or fewer counties. The computer then can provide an informative three-dimensional summary of these data. (Fig. 1) is an example, summarizing the distribution of rare plant species in Indiana. The height of the "landscape" on the graph represents the number of species in each of Indiana's 92 counties that only occur in five or fewer counties in the State. In (Fig. 1) the observer is looking at the State from the southeast at an elevation high above the surface. The highest peaks on the graph, in the northwest corner, represent approximately 130 rare species per county. Some counties (such as those in the east central part of the State) have no rare species.

Fig. 1 summarizes at a glance much information about the distribution of "rare" plants in Indiana, and is proof that one graph is worth a thousand data points! It presents reviewers unfamiliar with the State's flora a concise summary of the geographic areas that should be evaluated first for endangered species. Correlation of physiographic, climatic and other geographically oriented variables with the distribution of rare plants also is easier.

Summary statistics also are valuable to understand the plants and animals of Indiana. Summary statistics can be provided for each set of taxa—for example, the average number of counties in which each species occurs. Similar statistics can be compiled to answer questions about a particular geographic unit (such as the average and variance of the number of species per county in the State), or for particular ecological units (for example, the average and variance of the number of species in a community). Bivariate and multivariate analyses

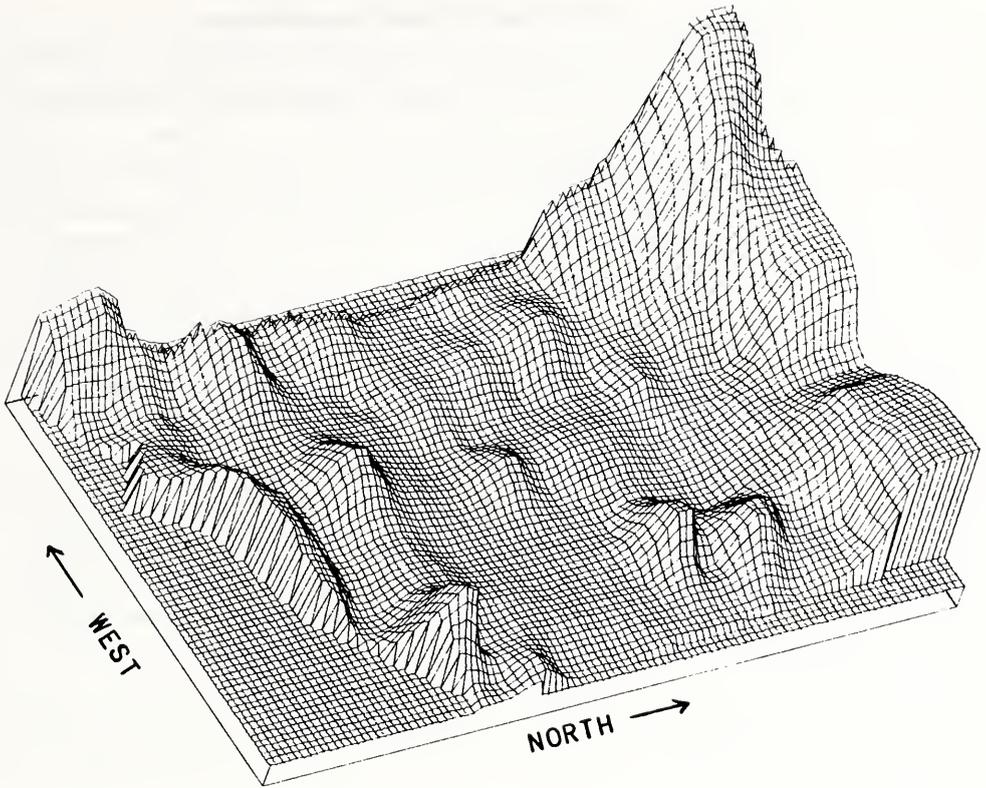


FIGURE 1.

have rarely been used in such studies. The potential is great, and IBS is building on previous experience (e.g., Crovello, 1972; Crovello and Keller, 1974).

To summarize Stage Five, in IBS we believe that conventional publications will always have value for the study of our environment and its inhabitants. But we also believe that computer results also will do much to deepen our understanding of the past, present and future status of Indiana's biota. Finally, in these days of tight budgets, routine computer use also should prove cost effective.

Stage Six: Publicity

The best biological information system is completely useless if potential users are unaware of it. Consequently, every appropriate medium is used to publicize the existence of IBS data banks—This includes the distribution of the minutes of meetings of the BSC, and BSC People Power questionnaires at Indiana Academy of Sciences meetings and by mail as part of the Newsletter of the Indiana Academy of Sciences. Reference is made to IBS data banks in talks on various subjects throughout the country. Publications and fliers explain its existence, availability and use. Members and correspondents of the BSC are urged to establish bulletin boards in their departments that provide information on BSC activity.

Interaction Of IBS With Other Organizations

Following the philosophy that the most valuable and complete work of the BSC will emerge from combined efforts of many people, both from within and outside of the Indiana Academy, continuous efforts are made to involve individuals and organizations throughout the State. To help in planning we have enlisted the aid of informed members of other relevant committees of the Academy, as well as the membership at large. We draw upon State employees, particularly in the Department of Natural Resources, who have provided both information and evaluation of our planned projects. Field workers involved in environmental impact statements who contact us for information are also asked to outline their views on the most urgent information needs for Indiana plant, animal and environmental data.

In data accumulation, we have used printed matter already published by various sources, including the Department of Natural Resources and The Ford Foundation. We are cooperating with the Indiana Natural Heritage Program. Similarly, conservation groups, such as The Audubon Society and The Issac Walton League, include many members knowledgeable in plants and animals. Many advantages will accrue if the lands of such organizations will be inventoried early. Finally, particularly with the woody plant species, we expect that the 4-H Club organization, which is partially funded in every State by the federal government, can be utilized as a source of taxonomic, geographic and ecological information.

Perhaps the largest interaction with other organizations and individuals will be in the area of data bank output. If handled correctly, the IBS data banks can serve many diverse organizations and individuals, including other committees such as the Science and Society Committee of the Indiana Academy, its individual members, and Department of Natural Resources personnel. It could serve as a data base for information on woody plants for such groups as the 4-H Club, Boy Scouts, or Girl Scouts. We plan to explore interactions with the State's Department of Public Instruction, both at the elementary and high school level. The Environmental Protection Agency and other federal organizations will or should find geographical, taxonomic, and environmental information on the plants and animals of the State of great value for many of their projects. National organizations such as Sigma Xi, the American Association for the Advancement of Science, and the American Institute of Biological Sciences, all have science and society committees. Once IBS is begun, it could be a routine task to provide such organizations with information of interest regarding species in Indiana.

Summary

To summarize, we may say simply that IBS is alive, growing, and dedicated to making Indiana and its people better. The long range goal of the BSC is to accumulate, maintain and disseminate information about the kind, quantity, and distribution of the biota of the State. Our philosophical point of view has always been that such surveys are an unending, multifaceted task (Constance, 1964). This task requires many people but it promises both tangible and intangible rewards to both participants and to society in general. IBS is a very

time consuming process, which time could have been spent in other activities. Nevertheless, we believe in the need for IBS and that in the long run it will serve both academic goals as well as those of Society.

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