EPA United States Environmental Protection Agency

Science Advisory Board (A-101)

EPA-SAB-EPEC-92-025
August 1992

AN SAB REPORT: REVIEW OF SYNOPTIC NATIONAL ASSESSMENT OF COMPARATIVE RISKS TO BIOLOGICAL DIVERSITY AND LANDSCAPES TYPES

PREPARED BY THE HABITAT BIODIVERSITY SUBCOMMITTEE OF THE ECOLOGICAL PROCESSES AND EFFECTS COMMITTEE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

August 11, 1992

OFFICE OF
THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

EPA-SAB-EPEC-92-025

Mr. William K. Reilly
Administrator
U.S. Environmental Protection Agency
401 M St., SW
Washington, D.C. 20460

RE: SAB Review of Synoptic National Assessment of Comparative Risks to Biological Diversity and Landscape Types

Dear Mr. Reilly,

The Habitat Subcommittee of the Ecological Processes and Effects Committee of the Science Advisory Board has completed its review of the Office of Research and Development's proposed project entitled "Synoptic National Assessment of Comparative Risks to Biological Diversity and Landscape Types". As you are aware, the SAB has recommended that the Agency develop a research program to address the significant problems and ecological risks contributing to the loss and modification of habitats. This proposal is the first substantive research effort that we have reviewed, and we are gratified by its attempts to grapple with critical scientific questions on habitat condition and responses to stress and to leverage the significant efforts of other Federal Agencies in this project. If this project is successful, it will provide important correlative evidence linking vertebrate richness with human induced stresses.

For this review, the Subcommittee was asked to address two general questions: a) Is the approach to a National Assessment of Comparative Risks to Biodiversity appropriate in scope, time frame and budget? and b) Is the proposed pilot study needed? In order to address these questions, the Subcommittee met on April 30 and May 1, 1992 to receive oral briefings from the collaborating agencies and discuss the merits of the proposal. The Subcommittee also received oral comments from the Office of Policy Planning and

Evaluation expressing concern about the limited resolution vegetative features that could be achieved with the type of satellite data proposed.

Overall, the Subcommittee commends the Agency for its collaborative efforts with other federal agencies and the Nature Conservancy. The Subcommittee believes that this project represents an important and essential step toward the ultimate goal of protecting habitats. The project also offers significant opportunities to test principles of landscape ecology, to compare the costs and utilities of various remote sensing platforms, and to establish a data base of great value to many resource agencies. The attached report offers several suggestions to accomplish these goals which should be addressed in the revised research plan. However, this project is also highly complex and it will require extensive coordination to benefit from expertise offered by the various collaborators. Therefore, the project schedule should extend the pilot test and the limited budget should focus on the pilot study as a means to understand the strengths and weaknesses of the data and validate some of the assumptions and uncertainties associated with the remote sensing and biodiversity information. This plan is incomplete with respect to one critical goal; it lacks research to investigate the relationships between the endpoints selected and the people's "values" of biodiversity. Because of the evolving nature of this project, we recommend that ORD establish a formal peer review through an advisory group of nationally recognized scientific leaders.

EPA has a strong legal mandate to protect the integrity of our ecological resources. Biodiversity is recognized as one of our most important resources. Habitat destruction is thought to be a major source of stress on biodiversity. EPA should have a major, integrative, national program in this area.

Thank you for the opportunity to review this critical area of science for the Agency. We look forward to hearing more on the progress of the pilot study and other research

proposals on identifying habitats and protecting biodiversity as part of the Five-Year Research Strategy. We also encourage EPA to work with other Federal Agencies, on a cost-sharing basis, to acquire and analyze Thematic Mapping data that can be used for a variety of resource protection programs.

Sincerely yours,

Raymond Loehr, Chair
Executive Committee
Science Advisory Board

Kenneth Dickson, Chair
Ecological Processes and
Effects Committee

Stanley Auerbach, Chair
Habitat Biodiversity Subcommittee

U.S. ENVIRONMENTAL PROTECTION AGENCY

NOTICE

This report has been written as a part of the activities of the Science Advisory Board, a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide a balanced expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency; and hence, the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency or other agencies in Federal government. Mention of trade names or commercial products does not constitute a recommendation for use.

US ENVIRONMENTAL PROTECTION AGENCY
SCIENCE ADVISORY BOARD
HABITAT BIODIVERSITY SUBCOMMITTEE
ROSTER

CHAIR

DR. STANLEY I. AUERBACH, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee

DR. DONALD F. BOESCH, University of Maryland, Cambridge, Maryland

DR. WILLIAM E. COOPER, Professor, Zoology Department, 203 Natural Science Building, East Lansing, Michigan

DR. KENNETH L. DICKSON, Director, Institute of Applied Sciences, University of North Texas, P.O. Box 13078, Denton, Texas

DR. FOREST HALL, Laboratory for Terrestrial Physics, Biosphericcs Branch (Code 923),Goddard Space Flight Center, NASA, Greenbelt, Maryland

DR. MARK A. HARWELL, Rosenstiehl School of Marine & Atmospheric Sciences, University of Miami, 4600 Rickenbacker Causeway, Miami, Florida

DR. CAROL JOHNSTON, NRRI, 5031 Miller Trunk Highway, University of Minnesota, Duluth, Minnesota

DR. WILLIAM H. SMITH, Professor of Forest Biology, School of Forestry & Environmental Studies, Yale University, 370 Prospect Street, New Haven, Connecticut

DR. WILLIAM E. WINNER, Department of Botany, Cordley Hall, Oregon State University, Corvallis, Oregon

US EPA/SCIENCE ADVISORY BOARD

DR. EDWARD S. BENDER, Designated Federal Official, 401 M Street, S.W., (A-101F), Washington, D.C.

MRS. MARCIA K. JOLLY (MARCY), Secretary to the Designated Federal Official

ABSTRACT

The report represents the conclusions and recommendations of the U.S. Environmental Protection Agency's Science Advisory Board regarding a research proposal entitled "Synoptic National Assessment of Comparative Risks to Biological Diversity and Landscape Types". The Habitat and Biodiversity Subcommittee reviewed this proposal and received briefings on the planned research from scientists with EPA, U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. Forest Service, and the Nature Conservancy. The Subcommittee supported the concept of the proposal but recommended the plan be revised to extend the schedule and expand the budget and address the recommendations herein. Further the Subcommittee recommended that the project focus on a longer term pilot to demonstrate feasibility, develop better indicators of stress, and compare various types of satellite imagery. They also encouraged further coordination among the participants and within EPA and with NASA. The Subcommittee noted that while the proposal offered many useful opportunities, EPA should be clear that they were only addressing issues of species richness at very coarse scales of resolution. The SAB also recommended that research be conducted to understand the basis for people's perception of the values of biodiversity and habitat.

KEY WORDS: Habitat Assessment, Biodiversity, Geographic Information Systems

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY 1

2. INTRODUCTION 2
2.1 Charge to the Subcommittee 2
2.2 Subcommittee Review Procedures 2

3. EVALUATION OF THE RESEARCH PROPOSAL 4
3.1 General Comments 4
3.2 The National Assessment of Comparative Risks to Biodiversity 5
3.2.1 Suitability of Approach 5
3.2.2 Adequacy of Budget 5
3.2.3 Probability of success 6
3.2.3.1 Species Occurrence Data 6
3.2.3.2 Landscape Type Data 6
3.2.3.3 Stressor Data 7
3.2.4 Alternative Approaches 7
3.2.5 Expert Judgment/EcoRisk Assessment 9
3.3 The Proposed Pilot 9
3.3.1 Is It Needed? 9
3.3.2 Potential Values 10
3.3.2.1. Resolution of scientific issues 10
3.3.2.2. Developing approaches to scaling 10
3.3.3 Changes for the Pilot Study 11
3.4 Building Bridges and Filling Gaps 12
3.4.1 Intra-Agency Cooperation 12
3.4.2 Relationship to EMAP and Other EcoRisk Programs in EPA 13
3.4.3 Collaboration with NASA 13
3.5 Opportunities for Scientific Research 14
3.5.1 Scale Issues 14
3.5.2 Anthropogenic Stressors vs. Natural Stressors 14
3.5.3 Retrospective Analysis 15
3.5.4 Valuing Biodiversity and Habitat 15

4. SUMMARY OF RECOMMENDATIONS 16

1. EXECUTIVE SUMMARY

A Habitat and Biodiversity Subcommittee of the Ecological Processes and Effects Committee of the Science Advisory Board was established and met April 30-May 1, 1992 to review a draft research proposal entitled "Synoptic National Assessment of Comparative Risks to Biological Diversity and Landscape Types".

The Subcommittee supported the concept of the proposal, but found that the schedule was too short and the budget was too limited to conduct a national assessment. Instead, the Subcommittee recommended that EPA concentrate on demonstrating the feasibility in several pilot studies that included habitats with diverse vegetative features and were subject to a range of anthropogenic stress. The Subcommittee also recommended that the pilots compare a variety of satellite data in combination with ground truthing and other forms of verification. Many of the sites for these pilots should be drawn from the sites currently under investigation by the Ecological Monitoring and Assessment Program (EMAP), particularly those in the eastern US which are subject to greater human impact.

The Subcommittee emphasized the need to establish a formal and continuing peer review process to conduct periodic evaluations of the pilot results and supporting research. The Subcommittee also encouraged the Agency to continue its collaborations with other Federal Agencies and to add NASA to it list of collaborators. EPA has a strong legal mandate to protect the integrity of our ecological resources and biodiversity. Habitat destruction is thought to be a major source of stress on biodiversity. EPA should have a major, integrative, national program in this area. The Subcommittee noted that EPA's major integrative contribution is based on the concept of risk assessment. However, the Subcommittee also recommended that EPA increase its efforts to develop indicators of stress for habitats. Several simple indicators, one for human presence (population) and another of habitat modification (miles of road), were suggested as preliminary indicators of stress within a habitat unit.

The Subcommittee also evaluated the potential for success of this proposal and other alternatives that could be pursued to accomplish the overall goal of a national assessment of habitats and their biodiversity. The Subcommittee cautioned EPA to make clear that this project is actually only measuring species richness and at a limited scale of resolution. However, the Subcommittee commended EPA and the participating organizations for strength and breadth of its collaboration at a scientific level.

2. INTRODUCTION

The SAB report, Reducing Risk: Priorities and Strategies for Environmental Protection (USEPA, 1990), characterized habitat modification and the loss of species diversity at the highest level of ecological risk. EPA has began work to identify steps it could take to address these risks. Although the members and consultants of EPEC are aware of some of these activities, this is the first SAB review of the Agency's research plan to assess the nature of the risks to habitats and biodiversity associated with them.

2.1 Charge to the Subcommittee

The Science Advisory Board received a request from Dr. Courtney Riordan, Director, Office of Environmental Processes and Effects Research, to review a research proposal entitled "Synoptic National Assessment of Comparative Risks to Biological Diversity and Landscape Types". Dr. Riordan noted that the primary goal of this review was to evaluate the proposed project plan within the context of EPA's five-year research strategy for Habitat/Biodiversity. In particular, the panel should address the following general questions with respect to:

a. National Assessment of Comparative Risks to Biological Diversity -- Is the proposed approach suitable for a national prioritization of risks to biological diversity? Are the budget and schedule realistic? If not, what changes are recommended? What is the probability of success. Are there alternative approaches that are as likely to be successful? Will the results be worth the costs? Will the proposed integration of regional risk assessment workshops, coupled with structured expert judgment, provide a useful check on data interpretation resulting from the quantitative analysis component and help to achieve consensus on priorities for management action? Should other alternatives be considered?

b. The Proposed Pilot Study – Is a pilot study needed? Will the proposed pilot study provide the information needed for a decision to proceed to full implementation of the national comparative risk assessment at the end of one year? If not, what changes are recommended? Are the budget and schedule realistic? If not, what changes are recommended?

2.2 Subcommittee Review Procedures

The review of the Habitat Proposal was assigned to the Ecological Processes and Effects Committee (EPEC) by the SAB. EPEC, in turn, established a Habitat and

Biodiversity Subcommittee to conduct the review. The ecological expertise of EPEC members was supplemented by consultants with expertise in landscape ecology and geographic information systems. In addition, valuable expertise in satellite platforms for defining landscape features was provided by a liaison from NASA. EPA provided the Subcommittee with a draft project proposal in March, and the Subcommittee met April 30-May 1, 1992 in Washington to receive briefings on the evolving project and to develop preliminary comments. Following discussions at the meeting, a draft report was developed and revised by the Subcommittee by mail. A recommendation for research in social science on the relationship between endpoints that are being monitored and people's perception of their values was suggested by the Executive Committee reviewers and was added to this report.

3. EVALUATION OF THE RESEARCH PROPOSAL

3.1 General Comments

The Ecological Processes and Effects Committee (EPEC) is pleased to see the Agency respond to the recommendation of the SAB's report Reducing Risk: Priorities and Strategies for Environmental Protection by proposing a research program on habitat modification and loss of species diversity. This is an extremely important problem for the Nation and, indeed, the biosphere as a whole. This project may influence the U.S. national strategy for conservation of biological resources and maintenance of environmental quality and serve as a model or stimulus for efforts on a state or regional scale.

The Subcommittee commends the Agency for its ambitious and diligent efforts to collaborate on the development of this proposal. We recognize that this project will be part of a five-year research strategy for Habitat/Biodiversity. We look forward to reviewing this overall strategy, which should include further research to support the regulatory and policy needs of the Agency and address scientific issues such as those identified below.

In reviewing this research proposal, the Subcommittee was cognizant of the recommendations for improving science in the Agency made in a recent report entitled "Safeguarding the Future: Credible Science, Credible Decisions". This report emphasized that EPA research, especially research meant to be in support of policy, must represent the best science and use of the scientific method that is possible to accomplish. This requires the use of the peer review system in the broadest sense, including preparation of peer reviewable research proposals, use of scientists or research groups either inside or outside the Agency. The use of on-site contractors as a matter of expediency usually does not result in the best science. The selection of peer reviewers must be based on their demonstrated qualifications and history of pertinent publications and in the area of proposed research. Research proposals for Science Advisory Board review should be in a condition to undergo formal outside peer review. It is only by the rigorous application of these precepts that science in the Agency can be expected to achieve the norms being followed elsewhere.

3.2 The National Assessment of Comparative Risks to Biodiversity

3.2.1 Suitability of Approach

The SAB report on the Relative Risk Reduction Project (EPA-SAB-EC-90-021A) identified habitat destruction and the resulting loss of species as a major issue that is not being addressed by current EPA programs. The proposed plan entitled "Synoptic National Assessment of Comparative Risks to Biological Diversity and Landscape Types" is the first major effort designed to respond to this challenge on a national basis. The partnership with the US Fish and Wildlife Service (FWS), the Nature Conservancy (TNC), US Forest Service (USFS) and the US Geological Survey (USGS) is a unique and scientifically superior approach to this problem. The data bases needed to identify the habitat (vegetative arrays) and biologic diversity (vertebrate species) are currently scattered among these various agencies/ organizations.

The use of the Environmental Monitoring and Assessment Program (EMAP) and the Geographical Assessment Program (GAP) sampling designs allows a hierarchical analytical structure that can address the issue of scale. This is the major scientific question that must be addressed in the early phase of the national program. Furthermore, these Geographic Information System (GIS) mapping technologies can produce spatial correlations of habitat types and species richness for review by expert panels at the prototype regional level. This validation effort will provide scientific credibility to the process before the program is scaled up to a national level.

If the correlative pattern between habitat and species richness is validated, then the issues of impact assessment and, possibly, risk assessment can be addressed for a variety of stress agents. The stressors will be restricted to that subset that directly affect habitat quality and quantity or indirectly affect species richness. Stressors that affect species survivorship directly cannot be addressed since there are no data on population size, resiliency, or dispersion in these analyses.

3.2.2 Adequacy of Budget

The project is divided into two components, Data Analysis and Risk Assessment, conducted over a three year period. Depending on which species are included in the

assessment of biodiversity and data bases of stressors, the total budget estimates ranged from $2,140,000 to $2,558,000. The panel was told during the review that the budget has been increased, but was not provided with any specific information.

The scope of the proposed research program is broad and complex. It is the opinion of the Subcommittee that the budget, as proposed, is inadequate to accomplish the stated objectives and that the time allocated is insufficient to accomplish many of the tasks. For example, the amount of effort allocated to compile, analyze, and integrate stressor data bases appear to be underestimated. Similarly, the proposed funding for the risk assessment workshops is inadequate, based on the experience of the Subcommittee.

3.2.3 Probability of success

3.2.3.1 Species Occurrence Data

The probability of success of the entire project hinges on this database, as it constitutes the only dependent variable being considered. While the TNC database may be an accurate representation of species richness at particular locations, there is substantial variability across sample locations. It will not be possible merely to interpolate between known data points, because intervening habitat and stressor conditions may be quite different. Measures have been taken to ameliorate these drawbacks, and attention was given to this issue in the QA procedures. Nevertheless, it is important that the anticipated methodology (use of expert opinion to interpolate data) be tested first against real data sets collected at a comparable scale (635 km^2 sampling units). If this test fails, the validity of the rest of the project is questionable.

3.2.3.2 Landscape Type Data

The Advanced Very High Resolution Radiometer (AVHRR)-derived vegetation types will be useful in predicting species richness if relationships can be demonstrated between the AVHRR vegetation types and wildlife occurrence. The advantages of the AVHRR databases are their comprehensive coverage for the U.S., their annual frequency, known relationships between Normalized Difference Vegetative Index (NDVI) and processes such as net primary production, and the fact that USGS is already preparing them. Their major disadvantage is their coarse spatial scale and generalized classification categories, in which anthropogenic and natural vegetation types are often mixed. The AVHRR data will not have a suitable resolution to detect some habitat factors that are important at the organism scale (e.g., habitat

fragmentation, food resources). These data also would not be indicative of non-habitat factors that may have a large influence on wildlife occurrence (e.g., disease, genetic diversity, hunting and trapping pressure). The success of developing empirical relationships will depend upon the extent to which factors undetectable by AVHRR influence wildlife occurrence. While the Subcommittee was skeptical about the probability of success in developing AVHRR-wildlife relationships, this represents a relatively inexpensive experiment that would be highly beneficial if such relationships can be developed, because of the low cost and annual repeat rate of the NDVI-derived vegetation types.

The AVHRR-derived vegetation types will be useful for risk prediction if they can detect anthropogenic impacts to habitat. This is not currently known, and will not be tested by the proposed research. Consideration should be given to these vegetation types in the long-term research plan: if AVHRR-wildlife relationships can be developed but the AVHRR data are not sensitive to anthropogenic change, its predictive use will be limited.

3.2.3.3 Stressor Data

Stressor measures should be simple, quantitative, and repeatable (e.g, miles of road, human population densities). The development of relationships between key stressor data and wildlife presence or absence are expected to have a high probability of success, because anthropogenic stressors probably have a more direct impact on wildlife richness than the more indirect impacts of vegetation change. This avenue of research would complement the ongoing research of the GAP program. Also, these anthropogenic influences could conceivably be regulated, so there is good potential for translating the scientific results into management strategy.

The researchers are cautioned, however, to concentrate on stressors that are likely to influence the dependent variable being measured, wildlife richness. While factors such as pesticide and fertilizer use may affect wildlife health, they will probably not affect species richness within a given hexagon. Since the focus of this research is on terrestrial species, the researchers should also focus on terrestrial rather than aquatic stressors.

3.2.4 Alternative Approaches

There are a number of parallel efforts that are currently being undertaken by a variety of research organizations. The NSF-LTER dedicated research sites, the EPA-Global Climate intensive and extensive landscape ecology research sites, the EPA-EMAP demonstration

projects, and the USFS-GAP program are all examples of landscape-scale data bases that will involve the identification of habitat diversity and species richness. The EPA habitat effort should be integrated with these in terms of impact endpoints, stressor definition and ground truth validation.

The EPA-Habitat/Biodiversity project will add two important dimensions to these other efforts. First, this project will eventually be scaled up to a national assessment tool. Second, the hierarchical approach will allow the issue of appropriate scale to be scientifically investigated; scale is a very important science issue that must be resolved.

The Subcommittee was concerned with the proposed plan to conduct a pilot study and rapidly expand to a national-level study. We recommend that whereas it is necessary to scope out the long-term goals of the research program, it is premature to plan that component in detail. Rather the pilot project needs to be planned more carefully with respect to addressing specific issues and evaluating specific hypotheses that must be resolved prior to expanding to the national scale. Further, limiting the research program solely to an expert judgment exercise, one of the alternatives suggested by EPA, is not recommended as it is unlikely to advance the understanding of key scientific issues.

Another alternative would be for EPA to develop a program that simply supports and enhances the GAP activity. The Subcommittee recognizes the unique contribution of risk assessment that EPA can make to the national effort to characterize the landscape and biodiversity of the US, and that to accomplish this most efficaciously will require a distinct EPA research program. EPA in particular would be a major contributor in characterizing the stresses, monitoring the status and changes in the extent of natural resources, and developing the methodologies for establishing ecological endpoints and indicators and conducting ecological risk assessments. Consequently, the Subcommittee supports development of a pilot study, as described elsewhere, in concert with GAP and other federal agencies programs but not merely as component of GAP.

One of the pilot areas should be used to test the suitability of different types of imagery: AVHRR, Multispectral Scanning System (MSS), and Thematic Mapper (TM). Although TM was mentioned several times in the revised pilot project outline, MSS has the advantage of low cost, spatial and spectral resolution intermediate between AVHRR and TM, and availability since 1972 (providing the potential for analyzing trends). The Subcommittee recommends that EPA work with other Federal Agencies to obtain and analyze TM data on a cost-sharing basis.

3.2.5 Expert Judgment/EcoRisk Assessment

The plans for developing a risk assessment component were not discussed substantively at the Subcommittee meeting. However, the draft research plan indicated that a formal Delphi approach would be used to evaluate comparative risk. The Subcommittee rejects this approach to compare riskS for several reasons; the Delphi approach advantage, in terms of process formalization, is outweighed by the loss of information that occurs in the consensus-building process. As an alternative, we recommend that the comparative risk/expert judgment process be an integral component of the pilot study, once the habitat, stress, and species richness data are accumulated. Then a workshop should be convened to examine the limitations in the data (e.g., lack of temporal resolution, species richness versus species diversity information) and to reach consensus on relative risks.

The Subcommittee also recommends that expert judgment be used to evaluate the extrapolation of species data across space as a necessary component of developing the species richness data base.

3.3 The Proposed Pilot

3.3.1 Is It Needed?

EPA must recognize that the assessment of biodiversity and landscape types is no lesser challenge than the assessment of the fate and effects of air and water pollutants or human health risks - issues that have been the focus of massive and long-term investment by EPA and other agencies. The Agency must understand that a sustained investment, commensurate to the magnitude of the problem, will be required. The goals of the proposed national assessment cannot be fully realized over a three-year period, but it should be considered a long-term project. Early efforts should evaluate, demonstrate, and inspire approaches to the problem rather than attempt to compile the definitive assessment.

In that regard, pilot studies of limited geographic scope constitute the only feasible approach for evaluation of techniques, demonstration of the method, and inspiration of efforts by levels of government within states which have more direct responsibility for landscape management. The selection of areas for pilot studies thus becomes very important. They should include regions with disparate biotopes, varying levels of human impact, well-characterized biota, historical records of change, and willing cooperators. The Subcommittee is concerned that the pressures to provide useable products within a short period of time will

force the extension of an inadequate approach on a national scale.

3.3.2 Potential Values of Pilot Study

Developing the proposed pilot study will be an essential step for the Biological Diversity Assessment Program. Pilot study efforts will have value early on for resolving scientific issues; demonstrating the application of remote sensing, and other techniques, to the issues of temporal and spatial scaling of biological phenomena; and providing a model of addressing a complex biological, resource management issue with an interdisciplinary, interagency program.

3.3.2.1. Resolution of scientific issues

Several scientific issues must be addressed within this program, and the resolution of these issues can only be shown with a pilot study. Examples of scientific issues to be resolved by the pilot study include:

*Analysis of stressors. Changes in the temporal and spatial distribution of species numbers will be compared with stressor distributions. The interagency team can use the pilot study to demonstrate how data on stressor distribution can be obtained, digitized, and mapped, how to partition the biological significance of stress between anthropogenic and other factors, and how to identify which stresses put biological diversity at greatest risk.

*Test relationship between species number and diversity. The pilot study will demonstrate whether mapping vertebrate species richness is a useful surrogate for biological diversity.

* Assessing risks to biodiversity. The ecological importance of biodiversity may be enough, alone, to justify the proposed biodiversity assessment program. In addition, the pilot study will show how spatial and temporal changes in biodiversity can be used to assess risks to habitats and to develop resource management approaches that go beyond single-species issues.

3.3.2.2. Developing approaches to scaling

Perhaps the most important value to come from the pilot study will be to develop and demonstrate how temporal and spatial features of the landscape can be scaled. Temporal

scaling is needed in order to use data from the past and present for predicting into the future. Spatial scaling is needed in order to take data from an array of sites and to infer across the landscape. Current tools used for scaling are not sufficient to predict future ecological trends or to identify landscape-level processes. The pilot study will demonstrate a unique approach in spatial scaling that exploits state-of-the-art techniques in remote sensing, data analysis, and modeling. The study will show the power of using both fine- and coarse-scale spatial resolution for assessing the status of natural resources.

Many of the issues addressed by EPA involve resources and policies associated with other federal agencies and with the private sector. The pilot study will demonstrate the need and ability of EPA to participate in the development of interdisciplinary, interagency scientific programs to protect the environment and manage natural resources.

3.3.3 Changes for the Pilot Study

The Subcommittee recommends that the pilot study take advantage of pilot and demonstration activities underway in EMAP or other resource agencies. As an example, during 1992 the EMAP Surface Water resource group is conducting an initial survey of lakes in the Northeastern United States that includes information on the taxa, species richness, and relative abundance of fish populations. These data could take the habitat program beyond the limitations imposed by considering only species presence or absence information to determine species richness, by adding abundance information that is necessary to evaluate species evenness and, consequently, species diversity. Thus, this EMAP pilot activity might be used in a habitat pilot to examine the critical hypothesis of the overall research program, (i.e., Is species richness an indicator of biodiversity?). Other EMAP pilot activities are underway for streams, forests, and near-coastal systems. The Subcommittee strongly recommends that the habitat/biodiversity research program explore with the EMAP program the opportunities for direct collaboration.

Pilot studies are a critically important component of the Synoptic National assessment. Pilots focus the strategy on specific sites and permit the following:

1. Identifying the availability, quality, and completeness of the relevant data sets;

2. Identifying appropriate state and federal cooperators;

3. Identifying weaknesses or correlation of landscape types, vertebrate species, and

anthropogenic stresses;

4. Testing hypothesis that vertebrate richness is correlated with habitat type at the scale proposed and that vertebrate richness is an index of biological diversity useful for risk assessment; and

5. Developing effective technology transfer of the strategy to resource/environmental managers.

More than one pilot should be planned. Diverse landscape types should be represented in these pilots. For example, Great Basin area is dominated by wilderness areas with low human population density. In contrast, a pilot in a high human population area (e.g., New England or mid-Atlantic region) would be an appropriate balance. The pilots should include sites that are important, e.g., in terms of endangered species, but also ones which are most easily accomplished because data are available and the approach is applicable with little modification.

The pilot study should consist of an initial demonstration project (over a 3-year time frame) using AVHRR data, species diversity data, and the GAP analysis to produce immediate results sufficient to attract larger funding levels. A program of more basic field and modeling research, involving university, government, and industry communities, should be fostered to investigate and develop improved methods. This program should be interdisciplinary in nature, preferably selected through a competitive, peer-reviewed process, and coordinated at a "low" level of intensity to ensure focus and relevance and to encourage the necessary interdisciplinary aspects. This program should be a balance of modeling, field experiment, and satellite data analysis.

3.4 Building Bridges and Filling Gaps

3.4.1 Intra-Agency Cooperation

It is again obvious that EPA has developed better cooperative agreement between agencies than it has within the EPA. There has been some integrated design between the Habitat/Biodiversity and the EMAP program. Further integration should be developed between the Habitat/Biodiversity program and those currently being funded by the EPA-Global Climate Impact programs. The community and population endpoints, the structure of the predictive models, and the issues of scale are common to both. The only major

difference is the identity of the stress factor.

The risk assessment and stressor identification components must be integrated with the EPA-Ecological Risk Assessment program, the EPA-Biomarkers program, and the EPA-OPPE parallel efforts. These entities appear to be competitive rather than supportive in their interactions. This must change.

3.4.2 Relationship to EMAP and Other EcoRisk Programs in EPA

The proposed research program may provide important contributions to other ecological programs in EPA. The use of the EMAP frame demonstrates an effort to coordinate activities and use a product generated by EMAP. The Subcommittee commends the project for this coordination. However, the Subcommittee recommends that consideration also be given to interacting with the EMAP Integration and Analysis component. Specifically, the proposed project contains some analysis approaches, such as the greedy heuristic model, which appear to have application to EMAP. In addition, the inclusion of a project investigating endpoints and the value people attibute them may develop concepts that are applicable to EMAP (See discussion below in section 3.5.4.).

3.4.3 Collaboration with NASA

There are a number of issues that must be addressed to use either AVHRR or Landsat to map vegetation classes. These sensors measure light at the top of the atmosphere that is reflected from the land surface. The amount of light that is reflected is primarily a function of vegetative community composition (overstory and understory), structure (tree morphology, tree density, spatial distribution), and substrate reflectance (soils, litter, understory). When looking at the AVHRR or Landsat images, it is quite apparent there is information in the image that is related to variations in vegetation community and structure across the landscape, and it is natural to assume that the variations in the image can be identified in terms of vegetation classes with which we are familiar with (forests, pasture, water, desert); however, for more subtle discriminations of interest here, the identification is not always straightforward. Seasonal variations in vegetative condition associated with drought or spatial variations caused by soil changes affect the relationship between reflected light patterns and the vegetation classes of interest. Even atmospheric opacity changes from dust and humidity can affect the patterns. In addition, the spatial resolution of the sensors vary ($>$ 10km for AVHRR, depending on view angle from radar, to 30m for Landsat TM). This variation can also affect the relationship between the light patterns and vegetation classes. For most

forested landscapes "patches" of a single species, 3 to 5 hectares can be resolved with AVHRR.

A large body of literature and expertise exists that has addressed these issues over the past 15 years - many of the most advanced techniques and expertise resides within the university community and NASA. It is strongly recommended that EPA seek a relationship with these communities to strengthen the scientific approach to the use of satellite data.

3.5 Opportunities for Scientific Research

The Subcommittee recommends active use of sensitivity analyses to explore the implications of data developed through the pilot program. For example, sensitivity analyses could demonstrate the consequences of different levels of aggregation of habitat types in terms of correspondence with species richness data. As another example, the temporally rich, spatially sparse data sets such as annual bird counts could be examined for the importance of inter-annual variability with respect to the methodology used to characterize spatial distribution of species. Also, by examining a higher resolution data base for habitat, such as from TM, MSS, or even aerial photography sources, spatial heterogeneity could be characterized at various level of spatial aggregation from the highest resolution of the data through successively coarse scales to the resolution of AVHRR data. This nesting of resolutions on the source region can help us understand the implications of data sources from one scale versus another for different habitat types.

3.5.1 Scale Issues

The proposed project provides a unique opportunity to examine the utility of various levels of remotely sensed data (AVHRR, TM, MSS, and Photography) to examine relationships between landscape properties and biodiversity. Specifically, the Subcommittee recommends that the pilot studies include an assessment of scale relationships, a fundamental question in landscape ecology.

3.5.2 Anthropogenic Stressors vs. Natural Stressors

Evidence must be presented that clearly links anthropogenic stressors of interest to habitat quality/quantity. Effects of natural stressors must be recognized and partitioned from human stressors of interest if correlations of stressors with habitat are proposed.

3.5.3 Retrospective Analysis

One desirable research study would involve a retrospective satellite analysis of a region which has experienced considerable landscape changes in the period of landsat records (1972) and has a vertebrate diversity data base for that period. Another research study could trade space for time to look at the relationships between vertebrate diversity and landscape characteristics.

3.5.4 Valuing Biodiversity and Habitat

The Science Advisory Board recommends that the research plan include steps to investigate the relationship between the endpoints of concern and people's perception of their values. This social science research should also be designed to verify that the habitat endpoints of value are correct and investigate the reasons that people want and appreciate those habitat endpoints. Such research would also assist the risk assessment process and facilitate communication of the assessment results to the risk manager. This type of research should help bridge the gap between the goals motivating the research and the evaluation of the research activities and findings.

4. SUMMARY OF RECOMMENDATIONS

Overall, the Subcommittee commends the Agency for its collaborative efforts with other Federal Agencies and believes that this project is an important step toward the ultimate goal of protecting habitats. In order to attain that goal and enhance the existing plan should be revised to address a variety of recommendations which are summarized below:

a. The Subcommittee urges the Agency to delay the National Assessment (about three years) until the techniques have been demonstrated in the pilot.

b. The Subcommittee recommends that EPA concentrate on demonstrating the feasibility of satellite data and biodiversity data (which is actually species richness information) through pilot studies that include habitats with diverse vegetative features, subject to anthropogenic stress.

c. The Subcommittee emphasizes the need for formal and continuing peer review and encourages EPA to promote national coordination and leadership to develop indicators of stress for habitats, to investigate the relationships between AVHRR data and habitats for wildlife, and other research questions.

d. The Subcommittee cautions EPA to clarify that this project measures species richness at a limited scale of resolution. The Subcommittee further recommends that the pilot studies be expanded to include an assessment of scale relationships. EPA should work jointly with other Federal Agencies on a cost sharing basis to obtain and analyze Thematic Mapping data on a shared-cost basis for comparison with other types of satellite data during the pilot.

e. The Subcommittee recommends that EPA research focus more effort on the development of terrestrial stressors.

f. The Subcommittee rejects the Delphi approach to compare the risks to habitats, but recommend that the comparative risk/expert judgement process be integral to the pilot and that expert judgement be used to extrapolate species data across space to expand the species richness data base.

g. The Subcommittee recommends that the pilot build on EMAP demonstration activities to evaluate relevant data sets; identify collaborators; test hypotheses on vertebrate richness and

habitat type, biodiversity and risk assessment; and develop a strategy to transfer this knowledge to resource/environmental managers.

h. The Subcommittee recommends that EPA add a social science research component to evaluate the relationships between the endpoints of habitat value and the people's perception of those values.

Distribution List

Deputy Administrator
Assistant Administrators
EPA Regional Administrators
EPA Laboratory Directors
Director, Office of Environmental Processes and Effects Research
Director, Office of Policy, Planning and Evaluation
Director, Environmental Monitoring Assessment Program
Director, Environmental Research Laboratory - Corvallis, Oregon
EPA Headquarters Library
EPA Regional Libraries
EPA Laboratory Libraries