



## Project Summary

# Arid Ecosystems Strategic Monitoring Plan, 1991, Environmental Monitoring and Assessment Program (EMAP)

Bill Kepner, Bruce Jones, Susan Franson, Carl Fox, Chris Elvidge, Virginia Enos, Janet Jackson, Michael Meyer, David Mouat, Martin Rose, Carol Thompson, Bob Breckinridge, John Baker, and John Flueck

The U.S. Environmental Protection Agency (EPA) at the recommendation of their Science Advisory Board initiated in 1988 the Environmental Monitoring and Assessment Program (EMAP). This program was initiated as part of the EPA Office of Research and Development (ORD) to monitor the status and assess trends in the condition of the nation's ecological resources. Information obtained from EMAP will assist in evaluating current environmental policies and identify emerging environmental problems before they become widespread or irreversible.

EMAP is organized into four major elements: resource monitoring, integration, coordination, and developmental research. Resource monitoring focuses on the collection and interpretation of field data on the ecological condition of 8 resource categories: agroecosystems, arid ecosystems, forests, estuaries, great lakes, coastal waters, surface waters, and wetlands. Integration activities are designed to facilitate the acquisition, management, and interpretation of monitoring data. Coordination involves ecological indicator selection, testing, and evaluation; monitoring network design and statistical analysis; logistics; and quality assurance. Developmental research focuses on improving scientific understanding through research programs including environmental statistics, ecological indicators, landscape ecology, and ecological risk characterization.

This document describes a strategy for establishing an integrated environ-

mental monitoring and assessment program for arid ecosystems in the United States. The EMAP Arid Ecosystems (EMAP-Arid) Strategic Plan is designed as a "living" document responsive to changes in the state of knowledge concerning arid ecosystems. The strategy is being developed in cooperation with all elements of EMAP as well as with key natural resource management agencies and institutions with responsibilities or expertise in arid ecosystems. The success of EMAP-Arid will depend on the integration and coordination among these arid ecosystem groups.

*This Project Summary was developed by EPA's Environmental Monitoring Systems Laboratory, Las Vegas, NV, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).*

### EMAP-Arid Strategic Plan

Successful development of an environmental monitoring and assessment program strategy requires a clear definition of the resources and issues of concern, establishment of goals and objectives, and formulation of a conceptual approach. This Strategic Plan addresses these three elements in order to move toward full implementation of EMAP in arid ecosystems.

### Arid Ecosystems—Definition

The EMAP-Arid resource group is responsible for perhaps the widest diversity of ecological resources within EMAP. Arid ecosystems are defined in EMAP as:



Terrestrial systems characterized by a climatic regime where potential evaporation exceeds precipitation, annual precipitation ranges from < 5 cm to 60 cm, and daily and seasonal temperatures range from -40 °C to 50 °C. The vegetation in arid ecosystems is dominated by woody perennials or graminoids with a low form physiognomy including drought resistant trees in open canopies. Arid ecosystems also include associated riparian areas occurring with the arid zone. Irrigated lands are not considered part of EMAP arid ecosystems even though they occur in the same climatic region.

This definition is designed to include the arid and semi-arid ecosystem resource classes considered important to EMAP. It also attempts to take into account boundaries (ecotones) between resource classes that may be important in monitoring environmental change.

### **Arid Ecosystems—Issues**

Arid and semi-arid ecosystems (referred to simply as arid ecosystems in this document) occur on most continents of the earth and comprise about one third of the land surface area. In the United States, arid ecosystems as defined by EMAP comprise nearly 40 percent of the land surface area and are important centers of commerce and human populations. Major environmental issues facing arid ecosystems include: grazing, biodiversity, desertification, water resources, air quality, and global change. Much of the concern over these issues stems from the tremendous increase in man's activity in arid regions of the United States over the last 40 years. While historically arid lands have been used by relatively small numbers of people, recent population explosions in conjunction with development practices have precipitated a rapid degradation in the resources of arid ecosystems. Observed deterioration in air quality, increasing demands and subsequent shortages of readily available water, and the loss of critical wildlife habitat can be linked to recent increases in human populations. With the prospect of global climate change, the recognized sensitivity of arid ecosystems to climate, and increasing evidence that arid ecosystems are intricately linked to and affect all other ecosystems, arid ecosystems can no longer be considered remote places of little value.

### **Goals and Objectives**

The EMAP-Arid resource group has developed an overall goal in concert with the goals and objectives of EMAP. The overall EMAP-Arid goal is to "Provide an unbiased estimate with known confidence of the current and changing conditions of ecological resources in arid ecosystems at the regional and national level." Specific objectives EMAP-Arid must meet to achieve this goal are to:

- Measure the status, evaluate trends, and estimate the extent of arid ecosystems using synoptic, retrospective, and sample-based methodologies.
- Determine the spatial and temporal correlation between stressor(s) (e.g., pollutants) and ecological condition and trends.
- Provide information to decision and policy makers and management, and regulatory and research agencies and institutes that can be utilized for comprehensive regional planning.
- Develop a regional interagency communication and data transfer network.

The EMAP-Arid resource group has also established 5- and 10-year goals. The 5-year goal is to establish baseline conditions, develop a management structure and procedures, secure interagency commitments, and assess the ability of EMAP-Arid to integrate information to determine regional ecological condition. The 10 year goal is to determine regional trends in the condition and extent of selected arid ecosystem resources and develop test scenarios to determine causes of regional alteration, degradation, or enhancement. Achieving these goals will depend on the success of pilot and demonstration studies, development of interagency agreements, program integration, and the availability of funding for monitoring and research activities.

### **Conceptual Approach**

EMAP-Arid is taking a holistic, ecological approach in the development of a strategy for monitoring and assessing the condition of arid ecosystems. Major components of the approach include the development of an overall strategy, formulation of a network design, identification of candidate indicators, and initiation of other EMAP coordination and integration activities.

### **Overall Strategy**

The overall EMAP-Arid strategy is to identify environmental issues and ecological endpoints, measure and integrate indicators of ecological condition, and evaluate

spatial and temporal variability to determine the status and evaluate trends in the condition of arid ecosystems. An important concept behind the strategy is the integration of synoptic (complete landscape coverage), sample-based, and retrospective indicator data with stressor information (e.g., climate and air quality). Combining these four indicator types provides a mechanism for characterizing arid ecosystem health, condition, and vigor over ecologically appropriate spatial and temporal scales. This approach also provides the ability to evaluate correlative relationships between stressor and ecological condition and enhance the identification of existing and potential environmental problems.

### **Network Design**

Three classes or "population" types have been identified for arid ecosystems and form the basis for the development of monitoring network designs for arid ecosystems. These design classes include (1) discrete resources; (2) elongated resources; and (3) extensive resources. Discrete resources are well defined and often are rare populations that require special attention because of their social and ecological value. For these resources the monitoring design would include either a systematic sample from a list frame or a probability-based sample from the EMAP base grid (12,600 points systematically placed across the U.S.). Elongated resources occur spatially in linear form (e.g., riparian communities along streams). Special care must be exercised to capture these resources in order to estimate their extent, distribution, and condition with the desired precision. Map frames, list frames, or conditional population frames constructed from prior information are likely to be used for elongated or linear resource monitoring. Extensive resources occur over broad areas (e.g., grassland, scrubland, and desertscrub formations). The resource map developed by Brown and Lowe will be used to define these resources and the EMAP point grid will be overlaid on the resource map to produce a probability-based sample. Approximately 50 to 100 units (e.g., 40-km<sup>2</sup> hexagons) will be sampled over a complete field cycle. Other designs will be considered as resources are identified and the availability and appropriateness of existing data evaluated. EMAP-Arid will integrate, to the extent possible, with other monitoring networks and research sites in order to scientifically and cost-effectively develop a comprehensive environmental monitoring and assessment program for arid ecosystems.

## Indicators

Identification and development of indicators for EMAP-Arid is based on linking environmental issues, ecological endpoints (i.e., sustainability, biodiversity, and aesthetics), and conceptual models. The indicators identified fall into three main groups—synoptic, sample-based, and retrospective. Candidate indicators currently considered have been further grouped and address vegetation biomass, water balance, landscape pattern, fire, retrospective analyses, wildlife habitat, or very specific issues (i.e., "canary sites"). These indicators generally measure primary productivity, nutrient cycling, species diversity, system stability, prevalence of disease, structure, and the occurrence of contaminants. The current, relatively long list of indicators will be reduced after being evaluated in pilot and demonstration studies. A list of "core indicators" will evolve and ecological indices (i.e., combined indicators) developed prior to full implementation of the program.

## Other Coordination and Integration Activities

Other coordination and integration activities will be a critical part of EMAP-Arid. These include (1) assessment of existing data, (2) logistics, (3) analytical considerations and measurement techniques, (4) quality assurance, (5) information management, (6) data analysis, (7) integration, and (8) development of EMAP-Arid outputs. Many of these activities will be similar to those developed and implemented in other EMAP documents (i.e., quality assurance, information management, program outputs). Others (i.e., logistics, analytical considerations, data analysis) are somewhat premature relative to their specific development for EMAP-Arid. However, assessment of existing data and integration are particularly important to the EMAP-Arid strategic plan.

## Evaluation of Existing Data

Maximizing the use of existing data, monitoring networks, and research sites is extremely important to the development of EMAP-Arid. A preliminary evaluation of existing information reveals that data which may be important to monitoring arid ecosystems are available from nearly every Federal agency (i.e., EPA, BLM, USGS, NOAA, USFWS, NPS, USFS, NASA, DOE, DOD, SCS, NSF) that interacts with natural resources. While these data bases have been identified, the challenge for EMAP-Arid lies in evaluating the appropriateness and integrating the information into the monitoring and assessment program.

## Integration

Perhaps the greatest challenge facing EMAP-Arid is integration. Three levels of integration have been identified—policy, program, and technical. Policy integration is the process of evaluating and coordinating the needs of EMAP-Arid clients and constituencies and ensuring that those collective needs are addressed by the EMAP-Arid components. Identification of users, development of appropriate contacts, inclusion of constituent groups in all steps of program development are part of the EMAP-Arid strategic plan. Program integration refers to the initiation and implementation of an efficient national monitoring program. Coordination of EMAP-Arid with ongoing monitoring programs (e.g., BLM) will avoid duplication, improve efficiency, and enhance the significance of the information collected in monitoring. Memoranda of understanding and cooperative agreements will be likely vehicles to help achieve this type of integration. Technical integration involves selecting, analyzing, and evaluating data in order to transmit the information into an environmental policy framework. Determining associations between stressors and ecological condition on a regional and national scale is an important component of

environmental monitoring and protection. The potential for integration in EMAP is almost endless. The EMAP-Arid resource group considers this task absolutely critical to its success and will devote considerable time and effort to achieving maximum integration at all three levels.

## EMAP-Arid Implementation

Implementation of EMAP-Arid will follow an extensive review of the strategic plan and completion of exploratory studies (pilot and demonstration projects) in each major resource formation (i.e., riparian, grassland, desertscrub, woodland, scrubland, and tundra). Several important design, indicator, and logistical issues need to be evaluated, field tested, and resolved before a regional sampling design(s) is selected and full implementation begins. Evaluation of the ability of EMAP-Arid studies to detect change will be critical to the implementation schedule. EMAP-Arid implementation and the steps leading to full implementation are viewed as a dynamic process which is sensitive and flexible to advances in our understanding of monitoring and assessing arid ecosystem condition.

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*The EPA authors, **Bill Kepner, Bruce Jones, and Susan Franson** are with the Environmental Monitoring Systems Laboratory, Las Vegas, NV 89193-3478. **Carl Fox, Chris Elvidge, Virginia Enos, Janet Jackson, Michael Meyer, David Mouat, Martin Rose, and Carol Thompson** are with the Desert Research Institute, Reno, NV 89506. **Bob Breckinridge** is with the Idaho National Engineering Lab, Idaho Falls, ID 83415-2213. **John Baker** is with Lockheed Engineering and Sciences Company, Las Vegas, NV 89119. **John Flueck** is with the University of Nevada, Las Vegas, NV 89154.*

**William G. Kepner** is the EPA Project Officer (see below).

*The complete report, entitled "Arid Ecosystems Strategic Monitoring Plan, 1991, Environmental Monitoring and Assessment Program (EMAP)," (Order No. PB92-93-100139/AS; Cost: \$35.00; subject to change) will be available only from:*

*National Technical Information Service  
5285 Port Royal Road  
Springfield, VA 22161  
Telephone: 703-487-4650*

*The EPA Project Officer can be contacted at:*

*Environmental Monitoring Systems Laboratory  
U.S. Environmental Protection Agency  
Las Vegas, NV 89193-3478*

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