Integrated Global Background Monitoring Network

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Over geologic time, the biological and geochemical cycles es-ential for life on earth evolved and established themselves in a armonious, self-perpetuating equilibrium. However, within the st 100 years and primarily because of industrialization, man's ac-vities have become so significant that they have the potential to dversely influence many of these cycles. For example, total global itrogen dioxide emissions are currently estimated to be 645 × 10^6 ons per year, including nitrous oxides emitted by bacterial ac-ons. Industrial sources, including transportation, are estimated t 52 × 10^6 tons, or eight percent of the total. Similarly, total lobal sulphur emissions are estimated at 237 × 10^6 tons per year, ith 34 percent coming from anthropogenic sources (Whelpdale nd Munn 1976). Patterson (1980) estimates that 99 percent of lobal lead emissions are anthropogenic in origin. Pacyna (1986) uts the figure closer to 96 percent, still a very large proportion of otal lead emissions.

While we cannot at this time accurately assess man's impact

on these major global cycles, a number of studies have demonstrated that anthropogenic materials have been transported long distances and deposited in reportedly pristine areas. For example, Elgmork et al. (1973) found that snow in remote areas of Norway contained high levels of sulphur and lead levels of 98 ug/liter and concluded that the pollutants originated in urban and industrial areas of western and central Europe. Johnson et al. (1972) and Schlesinger et al. (1974) reported high acidity, lead, cadmium, and mercury levels in mountainous areas of northern New England in the United States. It was postulated that the pollutants originated in the densely populated, industrial areas of the central and mid-Atlantic regions of the United States. Hirao and Patterson (1974) concluded that 97 percent of the lead found in a remote site in the western United States came from anthropogenic sources. Anas and Wilson (1970) reported DDT levels in the milk and fat of northern fur seal pups. Other studies (Lannefors et al. 1983, Carlson 1981, Rahn 1981) examined potential contamination of the Arctic atmosphere from a variety of mid-hemisphere populated and industralized areas.

A number of studies have been carried out to establish reference levels of compounds with both natural and anthropogenic sources. For example, some researchers have looked at the composition of precipitation from remote areas of the world. Included were such constituents as hydrogen ion concentration, calcium, magnesium, sodium, potassium, ammonia, sulfates, nitrates, chlorides, silicates, and phosphates (Keene et al. 1983, Galloway et al. 1982). Others have looked at atmospheric concentrations over continental and marine areas at varying altitudes for nitrates, sulfates, chlorides, and ammonia (Huebert and Lazrus 1980).

Trace metals also have both natural and anthropogenic sources. Rahn (1976) reviewed the literature up to 1975 concentrating on the composition of atmospheric aerosols with emphasis on remote areas. This effort was updated in 1986 by Wiersma and Davidson.

One of the more significant problems of trying to determine man's impact on global cycles is not knowing what "natural" levels should be for both abiotic processes (e.g., gases and trace elements) and biotic processes (e.g., ecosystem functions). A well-designed, coordinated network of baseline stations in remote areas around the world can provide a data base that will allow current estimates to be made of biotic and abiotic baseline conditions. These baseline conditions will then facilitate better comparisons ith more impacted areas and thus contribute to a more complete ıderstanding of man's impact on his world.

This paper examines the history of background pollution monoring at the international level, describes current activities in the eld of "integrated" background monitoring, and proposes critea for the development of a global network of baseline stations › coordinate background monitoring for the presence, accumuıtion, and behavior of pollutants in remote ecosystems. In this aper, the network is called the Integrated Global Background Ionitoring Network.

The objectives of the Integrated Global Background Monitorıg Network are:

- To establish reference levels for pollutants that have both anthropogenic and natural sources;
- To serve as an early warning system for detecting global spread and trends of pollutants that have only anthropogenic sources;
- To establish background levels for selected ecosystem parameters against which data from more impacted areas can be compared;
- To contribute to the study of biogeochemical cycles.

BACKGROUND MONITORING

The general concept for a global baseline monitoring system ıas been discussed for over 20 years. As early as 1965, a US Presidential Advisory Committee called for worldwide background ecosystem studies (Wenger et al. 1970). Lundholm (1968) recommended the establishment of a global background monitoring ystem based on a network of remote areas around the world.

Since then, scientists throughout the world have re-emphasized he need for a global monitoring system and for the establishment f a global network of ecological baseline stations (Ecological Reearch Committee 1970, Ad Hoc Task Force on GNEM 1970). enkins (1971) suggested that the stations should be representaive of the major ecological biomes of the world and be equipped o measure pollutants. Sokolov (1981) also urged that particuar attention be paid to integrated background monitoring, which vas defined by a 1980 Expert Group Meeting in Geneva as "the epeated measurement of a range of environmental variables or ıdicators in the living and non-living compartments of the enironment, and the investigation of the transfer of substances or

energy from one environmental compartment to another." Izrael (1982) pointed out the early warning value of a global network of background monitoring sites. Rovinsky and Buyanova (1982) observed that such a network of background monitoring sites could provide a basis for international environmental protection.

The World Meteorological Organization (WMO) Executive Committee (now "Executive Council") in its Resolution 17 proposed that:

> (F)or general scientific and economic reasons, members of WMO should ... as far as possible be prepared to meet requirements for environmental monitoring in other media (than air) as formulated by national or international organisations ... (M)onitoring in soil and biota should also be accepted to be carried out at background air pollution stations as far as feasible.

The idea of a Global Environmental Monitoring System (GEMS) was debated at Stockholm, Sweden, in 1972 at the UN Conference on the Human Environment, and a GEMS Program Activity Center was established in 1974 within the Nairobi, Kenya, headquarters of the United Nations Environment Program (UNEP).

An interagency working group (Task Force II: Committee on International Environmental Affairs 1976) was convened in 1974 to determine what should be monitored and to make recommendations for the structure and operation of an environmental assessment service within UNEP. The working group proposed an "Earthwatch" component within UNEP which would have four integral parts: monitoring (GEMS), research, evaluation, and information exchange. The working group also established the principle that environmental assessment should be carried out, wherever possible, in cooperation with similar activities, either existing or planned.

In addition, the International Environmental Programs Committee (1976) of the US National Research Council suggested linking MAB's Biosphere Reserve Program to terrestrial monitoring within GEMS. Franklin (1977) also argued that biosphere reserves be considered a component of GEMS. Herman et al. (1978) and Wiersma et al. (1978) described potential monitoring activities in US biosphere reserves. Finally, the International Coordinating Council of the Program on Man and Biosphere (MAB) (Anon. 1978) officially recognized the link between GEMS and MAB's Biosphere Reserve Program.

Currently, only WMO has a worldwide background air pol-
tion monitoring network which is known as BAPMoN (Kohler
)80). However, only about 10 percent of the more than 100 BAP-
[oN sites are truly "baseline" (de Koning and Kohler 1978). The
:rminology is slightly confusing: WMO uses "background mon-
oring" to refer to the entire BAPMoN network and "baseline"
) designate very remote sites, which in this paper are referred
) as "background." In BAPMoN, the term "baseline" is being
eplaced by "global," indicating the largest representativeness of
monitoring location (> 3,000 km). Other categories of monitor-
ıg locations are designated "continental" (> 1,000 kilometers)
nd "regional" (> 300 km). Several workers (Jensen and Brown
980, Anon. 1980) have stressed a need for terrestrial background
nonitoring stations that could provide correlated measures of pol-
utant behavior in different environmental media (air, water, soils,
)lants, and animals). Particular attention has been focused on the
3APMoN baseline sites.

The Geophysical Monitoring for Climatic Change (GMCC)
program (Mendonca 1979), the Global Precipitation Chemistry
Project (Keene et al. 1983), and other similar programs also col-
lect data on atmospheric constituents in remote areas. While more
limited in scope than the Integrated Global Background Monitor-
ing Network, the data collected should be valuable and should
be considered in the development of the Integrated Background
Monitoring Network. Eventually, many of these activities should
come under the new International Geosphere Biosphere Program
(IGBP).

GEOGRAPHICAL BASIS FOR A PROPOSED INTEGRATED BACKGROUND MONITORING NETWORK

An Integrated Global Background Monitoring Network must
have a geographic basis. An ideal candidate for this geographic
basis is the existing international Biosphere Reserve System of
the MAB Program. There are over 226 biosphere reserves in 62
countries, and over 40 are located in the United States. Obviously,
the existing biosphere reserves are far too many for an operational
global network. Estimates vary as to the number of sites necessary
for representative global coverage. Rovinsky and Buyanova (1982)
estimated that 30 to 40 sites would be needed. Jenkins (1971)
estimated 20, with at least two stations in each of the following

biome types: deciduous forest, coniferous forest, tropical forest, savanna, thorn scrub, grassland, desert, and tundra.

Many of the biosphere reserves are not suitable for background monitoring. Wiersma (1981[a]) examined the Biosphere Reserve System in some detail in order to determine which reserves were potentially suitable for background monitoring. The establishment of selection criteria is critical to making an effective choice. The most applicable criteria would seem to be those established for the WMO Background Monitoring Stations as modified in 1979 (WMO 1979). However, a second set of site selection criteria presented by WMO in 1980 appear more directly applicable to the selection of biosphere reserves for background pollutant monitoring. With the removal of reference to specific sites, these criteria formed the basis for the final selection criteria used. The criteria were then divided into two categories: "mandatory" and "desirable." In order to be selected, a site had to meet the mandatory criteria but not necessarily the desirable criteria. Both sets of criteria are described in Table 1.

Actual selection of a subset of reserves based on these criteria is preliminary at this time. Selection was based only on the information available in the Directory of Biosphere Reserves (UNESCO 1979) which covered the 171 biosphere reserves established at that time. The number of biosphere reserves currently in the system has expanded, and the more recent additions should eventually be reviewed for possible use in a background monitoring network. Additional information is also necessary to develop a final list of candidate sites. Examples of the need for additional information beyond that found in the Directory of Biosphere Reserves are:

- Inventories of pollutant emissions and anthropogenic activities within several hundred kilometers of the study area and for a foreseeable future time;
- More information on availability of flora and fauna data;
- More information on past and current research programs;
- Review of existing data bases covering physical data sets (i.e., meteorology, hydrology, soils, etc.);
- More details on the site facilities available;
- Evaluation of reserve position vis-a-vis major air mass trajectories;
- Evaluation of reserve position with regard to major climatic regimes (including types of prevailing air masses);

Table 1

Selection criteria

Mandatory Criteria	Desirable Criteria
1. Size. The size of a reserve can help ensure that several of the WMO integrated monitoring site selection criteria can be met. For example, adequate size will help minimize local influences. It would help ensure that an adequate core area existed and would help shield it against changes in economic activity in surrounding areas. Size chosen was 20,000 ha.	1. Underdeveloped surrounding areas. This would ensure the size and existence of a buffer zone. This criterion, however, was partly met by a mandatory criterion on size; therefore, the criterion was listed as a desirable rather than a required criterion.
2. Access. The area should be reasonably accessible, but intensive activities such as a large number of automobiles, etc., should be restricted.	2. No history of disturbance. While this would ensure a natural ecosystem in the reserve, in practice it would be difficult to find very many reserves which could meet this criterion fully.
3. Protection. The areas should have institutional protection (i.e., state or federal government) in perpetuity. This will not only help protect the area, but in some cases could significantly alter development in the surrounding areas.	3. Permanent staff greater than five. This is based on the premise that the larger the resident staff, the greater is the possibility that the reserve will have suitable facilities and ongoing activities that would be useful to the monitoring program.
4. Staff. The reserve should have a permanent staff. This would increase (but not guarantee) probability that the following services will be available: a) protective oversight; b)scientific studies; c) logistical staging areas; and d) personnel available to carry out routine measurements (e.g., change sample filters).	4. Scientific research underway. Three kinds of research were envisioned: a) pollutant monitoring (abiotic); b) impact studies which could include pollutant monitoring; and c) basic ecology studies.
5. Vegetation. The reserve should have a vegetation type approximately representative of a major biogeographical type in the world.	5. Data availability. The presence of background data for a reserve is not ensured merely because research activities are underway. Examples of essentially required data are: meteorological, geohydrological, geophysical, soils, geohydrological, and biological. The latter would include items such as species lists, forest type, maps, census data, etc.

- Ability and willingness of host country to carry out pollutant monitoring programs;
- Types and quality of graphical support data (e.g., maps, aerial photographs, satellite photographs).

In addition, final selection of integrated global background monitoring sites should not necessarily be limited to biosphere reserves; other sites should be considered as appropriate.

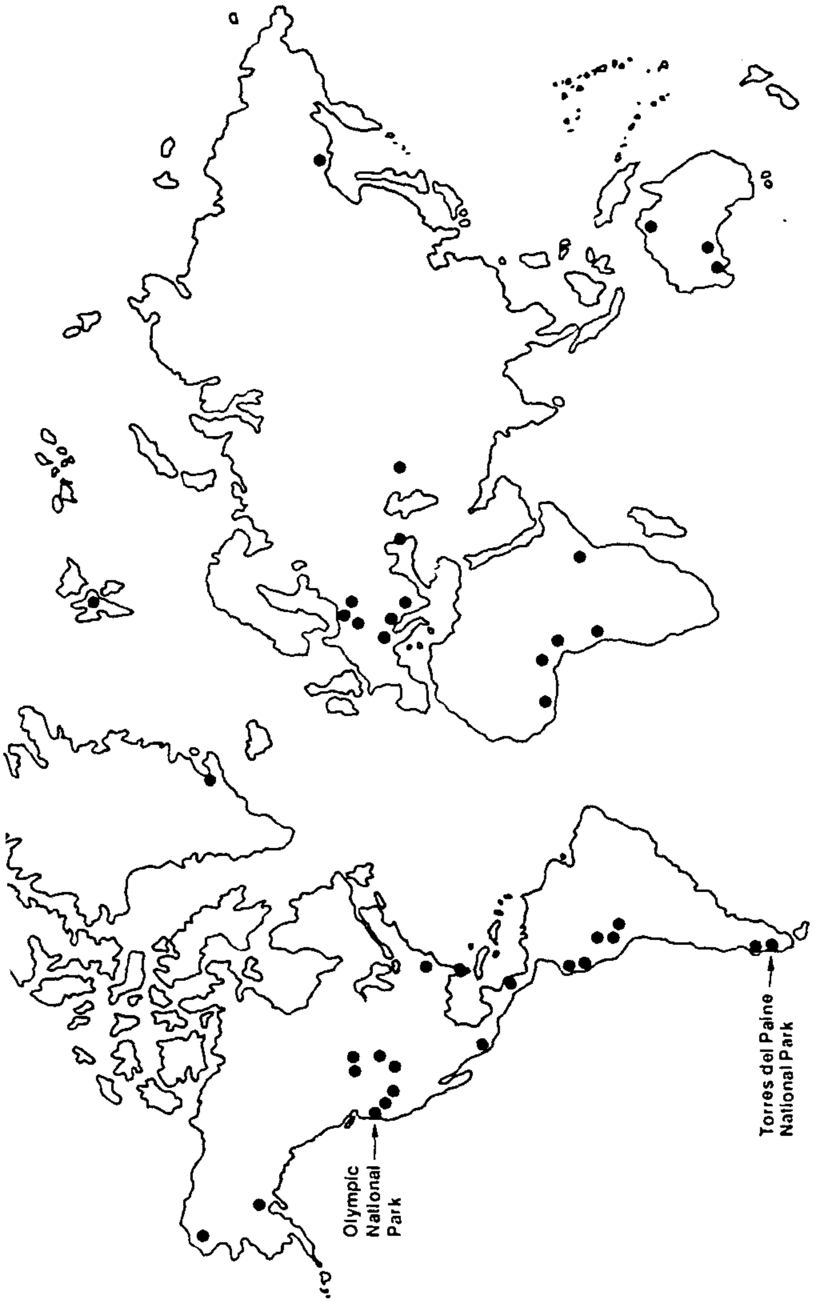
Using the ten selection criteria defined in Table 1, an initial screening of the 171 reserves listed in the Directory of Biosphere Reserves yielded 41 potential reserves for background monitoring. The geographical distribution of these reserves is shown in Figure 1. In general, they represent a good pattern of global distribution.

The 41 reserves cover eleven of the fourteen potential biomes. Certain biomes are more heavily represented than others. The mixed mountain and highland systems zone has a large number of reserves. Other biomes with a relatively large number of reserves present are the tropical dry or deciduous forests and the subtropical and temperate rain forests. Final selection of biosphere reserves to be used in the Integrated Global Background Monitoring Network is still to be determined.

APPROACH AND DESIGN PRINCIPLES

Within the context of this paper, it is not appropriate to discuss many of the details of sampling and monitoring design for the Integrated Background Monitoring Network. Much of this work has been done and can readily be adapted to monitoring in background areas (Wiersma and Brown 1980, Wiersma and Brown 1981, Wiersma et al. 1979, Wiersma 1981[b], Davidson et al. 1985, Rovinsky and Wiersma 1986). However, it is important to outline the principles under which an integrated background monitoring network will operate. The five basic principles which follow will be discussed separately below:

1. The monitoring system should be *multimedia* (integrated).
2. A *systems approach* should be used to relate media and help understand possible interactions between pollutants and ecosystem parameters.
3. Multicompound analytical chemistry procedures to measure *pollutants* should be used where possible.
4. *Key ecosystem (biotic) parameters* should be measured.



JRE 1 Biosphere reserves potentially suitable for biosphere reserve toring.

5. *Quality assurance* techniques should be applied during all phases of the project.

Multimedia System

An ideal monitoring system should be able to trace a pollutant from a source to a sink or exit point. In most remote terrestrial areas the pollutant input to the reserve site is via the air route. Specific sources, while generally associated with man's activity, are in practice difficult to locate. Therefore, input should be measured at the background site in the form of atmospheric concentrations as well as dry and wet deposition. Output from most background sites will be streams and rivers draining the area, and the loss of pollutants via this route can be determined by sampling representative drainages.

The multimedia monitoring approach integrates readily with data on ecological processes which are collected during the monitoring activity. However, it is highly unlikely that pollutant-related effects in remote areas will be detected. The greatest value will be in establishing baselines and long-term trends and in helping to understand cycling of compounds in the studied ecosystem. In addition, if long-term changes in ecosystem parameters are noted, then a good pollutant data base coordinated with the ecosystem parameters exists.

Systems Approach

Munn (1973) stated that it is essential that GEMS be designed to allow interactions between media to be studied, permitting delineation of the pathways of biogeochemical cycling. This requires a systems approach and is as applicable to the design of a system for a remote site as it is to putting the entire GEMS system together. A promising technique for accomplishing this is the use of kinetic models. Theoretical bases and applications of these models have been described in detail by O'Brien (1979), Miller and Buchanan (1979), Barry (1979), Eberhart et al. (1979), Wiersma (1979), and Wiersma et al. (1984).

Pollutants (Abiotic Parameters)

Many compounds exist which have both natural and anthro- ›ogenic sources. Indeed, one of the objectives of the Integrated Global Background Monitoring Network is to establish reference evels which will help separate natural influence from man's influ- nce. However, for simplicity, the term "pollutant" refers in this aper to any measured compound.

The selection of a limited number of pollutants to be mea- ured in background areas has been recommended by many sci- ntists concerned with monitoring systems development in these reas (Munn 1973, Task Force II: Committee on International En- ironmental Affairs 1976, Ad Hoc Task Force on GNEM 1970). Virtually all the suggested pollutants have potential for long-term ransport. However, advances in analytical chemical techniques llow for reconsideration of this approach.

For example, trace element techniques for a variety of media re now multi-elemental (Jaklevic et al. 1973 and 1976, Dzubay nd Stevens 1975, Alexander and McAnulty 1981, Kahn 1982). Multi-residue techniques for trace organics are currently available or most environmental samples. With these new procedures, prior efinition of the pollutants to be monitored is no longer necessary. n addition, these new techniques provide us with a true early arning capability, albeit at a higher cost. *In situ* measurements re necessary for parameters such as pH, conductivity, O_3, NO_x, nd SO_2.

Key Ecosystem (Biotic) Parameters

There is no unanimity of opinion on the array of ecosystem pa- ameters that should be selected for study as part of a monitoring etwork, although extensive lists of parameters have been devel- ped (Anon. 1980, Institute of Ecology 1979, National Science oundation 1977 and 1978). However, general agreement does ex- t on the need for measures of nutrient cycling, productivity, and opulations of selected species.

Selected species may either be dominant in the ecosystem or nsitive to pollutant perturbations. Parameters which meet these iteria include: litterfall or leaf fall (McShane et al. 1983[a]), tree owth, tree reproduction, tree mortality, changes in the com- iment of foliage (e.g., years of conifer needle retention), and

changes in the composition of the decomposer community. Sensitive species may be plants (e.g., some lichen species) or animals (e.g., some birds and small mammals) and their sensitivity may be reflected in their population structure or growth rates. A similar selection of parameters can be made in stream or lake ecosystems.

Ecosystem processes are a challenging aspect of any monitoring program. Background data must be developed for natural, unpolluted systems if it is not currently available. These data can then be used as a baseline against which other presumably polluted ecosystems can be compared.

The selection of specific parameters and sampling techniques is problematic. Ecosystems are a complex web of linkages, making it difficult to isolate the phenomena of interest in either the sampling or analytical phase of research. The possibility of observer effects is always present, especially since measurements are repeated over many years. Statistics of candidate ecosystem parameters are also critical (Hinds 1984). It is therefore necessary to select processes which are sensitive to subtle changes and have natural levels of variability which allow statistical detection of deviations from the norm (McShane et al. 1983[b], Hinds 1984).

Permanent plots are an important element in the ecosystem monitoring program. Monumented field sites are critical for accurate measurements of ecosystem or demographic processes. Sampling of permanent plots can also provide thorough descriptions of key community and ecosystem parameters (e.g., standing crops of organic matter) essential to measurement, or interpretation of parameters of more specific interest in the pollutant monitoring program. One scheme for establishing permanent sample plots is the reference stand system used at Olympic (Franklin 1982), H.J. Andrews (Hawk et al. 1978), and Sequoia-Kings Canyon Biosphere Reserves.

Quality Assurance

A complete quality assurance program should include organization and personnel, facilities and equipment, analytical methodology, sampling and sample handling procedures, quality control, and data handling. The quality assurance program for the Integrated Global Background Monitoring Network ultimately must incorporate all of these elements to help ensure data comparability among sites.

THE INTEGRATED GLOBAL BACKGROUND MONITORING PILOT PROJECT

At a series of United Nations interagency and expert group meetings in Geneva and Nairobi, steps were taken to start an Integrated Global Background Monitoring Pilot Project (Anon. 1980). UNEP agreed to establish background integrated monitoring pilot sites in three biosphere reserves as part of the renewable resource monitoring component of GEMS and in cooperation with WMO and UNESCO. The reserves were to be located in Chile, the USSR, and the United States.

A tentative design for monitoring basic ecological processes as well as pollutants was established (WMO 1980), and a project was implemented initially in two biosphere reserves: the Torres del Paine National Park in Chile and the Olympic National Park in the United States. Thus, GEMS is now using the biosphere reserves as part of its terrestrial renewable resource monitoring program.

The pilot network has the following objectives:

To develop a strategy and guidelines for global integrated background monitoring (site selection, sampling programs, sampling procedures, parameters monitored, data reporting and handling, etc.) on a routine basis, using the most cost-efficient approaches;

To establish reference levels for pollutants that have already produced low-level, global contamination;

To establish baseline levels for selected ecosystem parameters against which data from more polluted areas can be compared;

To serve as an early warning system for detecting long-range transport of pollutants and changes in ecosystem processes.

In the USSR, there have been many activities in the area of background integrated monitoring. Rovinsky and Buyanova (1982) describe 22 background locations in the countries of the Council for Mutual Economic Assistance (CMEA). Rovinsky et al. (1982) also describe three sites within the USSR at which integrated background monitoring is taking place: Borovoye, Berezinskiy, and Repetekskiy. Rovinsky et al. (1983) reported on background monitoring in the Berezinskiy biosphere reserve and describe the sampling locations, monitoring program, and results from 1980 to 1982.

The projects in Chile and the United States are dependent upon available funding. The data sets collected in Torres del Paine National Park (Chile) and Olympic National Park (United States) will be integrated using the systems approach previously described.

Torres del Paine National Park

At Torres del Paine National Park, a Strohlein 150 high volume air sampler is being operated according to WMO specifications. Sampling times are for alternate 10-day intervals. Samples are analyzed for Al, Cd, Cu, Pb, and Zn. A GMWL high volume air sampler is operating in parallel with the Strohlein 150. A low volume, solar powered air monitor is also operating and samples are analyzed for the same elements.

Only wet deposition samples are collected. Dry deposition samples are planned although sampling will not be implemented until a standard, internationally accepted, dry deposition sampling procedure is developed. Two wet deposition samples are operating at the park. One is a two-bucket Aerochem sampler operated by the Global Precipitation Chemistry Project. The second sampler is an Erni automatic one-bucket sampler. For the first year of the study, samples from both devices will be analyzed by the Global Precipitation Chemistry Project. In the second year, samples will be split between the International Atomic Energy Agency (IAEA) laboratory in Vienna and the Global Precipitation Chemistry Project. A DeSaga automatic impinger sampler, prepared for sampling SO_2, has also been installed.

Water samples are collected monthly from the Chorillo Zapata, a stream draining the watershed containing the reference stand. Moss and lichen samples are collected twice a year, and soil and forest litter samples are collected yearly in the reference stand located just west of the major cordillera in the park. Samples are analyzed presently for 20 to 30 trace elements using spark source emission spectroscopy and inductively coupled plasma emission spectroscopy.

The reference stand is a mature lenga stand (*Nothofagus pumilio*). It was selected to be representative of the characteristics of mature lenga stands in the area. Detailed ecological studies are currently being conducted by researchers from the University of Chile. These studies include characterization of the reference stand to species, age and size classes and standing biomass, an overall vegetation inventory for the park, and studies on litter decomposition and turnover rates.

Recently, specialized studies were undertaken to measure SO_2, NO_2, and total oxidant levels in the park. A quality assurance program has been instituted for this project. Weather parameters are also measured in the park.

Olympic National Park

At Olympic National Park, a low volume air sampler has operated in the Hoh River Valley. A high volume air sampling station will be established when funds are available at a site yet to be determined. Siting is critical to avoid local contamination from slash burning, campfires, and parking lots. Analyses will be the same as for Torres del Paine National Park, with the addition of nitric acid in the high volume air samples. Sampling periods are approximately the same as for Torres del Paine National Park. It is also planned to eventually sample SO_2, NO_x, and O_3.

As in Chile, dry deposition measurements are not being made at this time. Wet deposition samples are being collected at a National Atmospheric Deposition Program (NADP) sampling station at the Hoh River Ranger Station. Also as in Chile, water, soil, forest litter, and moss samples are being collected. Analyses are carried out for trace elements by spark source emission spectroscopy and inductively coupled plasma emission. In addition, priority pollutant scans for approximately 100 organic compounds have been made on the soil, litter, and vegetation samples. Water samples are collected from a stream draining the area.

The reference stand is primarily a Sitka Spruce/Western Hemlock ecosystem. The stand has been characterized for standing and down biomass, species composition, and age and size classes. Specific studies on six ecosystem parameters are being measured: lichen productivity, moss productivity, leaf litter fall, litter decay rates, nutrient flux in soil, and needle population structure. In addition, a significant study by the University of Washington is underway on nutrient cycling on a watershed basis in the same area.

A quality assurance program has been instituted for this project. Weather parameters are being collected at the park and

within the stand and are also available from the US Weather Service Station at Quillayute.

CONCLUSIONS

Experience in integrated monitoring of Biosphere Reserves and examinations of criteria for background monitoring and for characteristics of existing Biosphere Reserves lead to the following conclusions:

- An integrated global background monitoring network for pollutants and ecosystem processes should be established.
- Pollutant measurements should be made simultaneously in a number of environmental media.
- Cross-correlated ecosystem parameter studies should be carried out simultaneously with pollutant measurements.
- Monitoring in the proposed international network should be continuous and open-ended.
- The proposed network should consist initially of sites chosen, as appropriate, from the international MAB Biosphere Reserve System.
- The network should be under the overall coordination of the Global Environmental Monitoring System (GEMS) of UNEP, and, as such, it should be operated in close cooperation with the WMO Background Air Pollution Monitoring Network (BAPMoN). Other international agreements such as the US-USSR environmental agreement can also play a significant role.

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