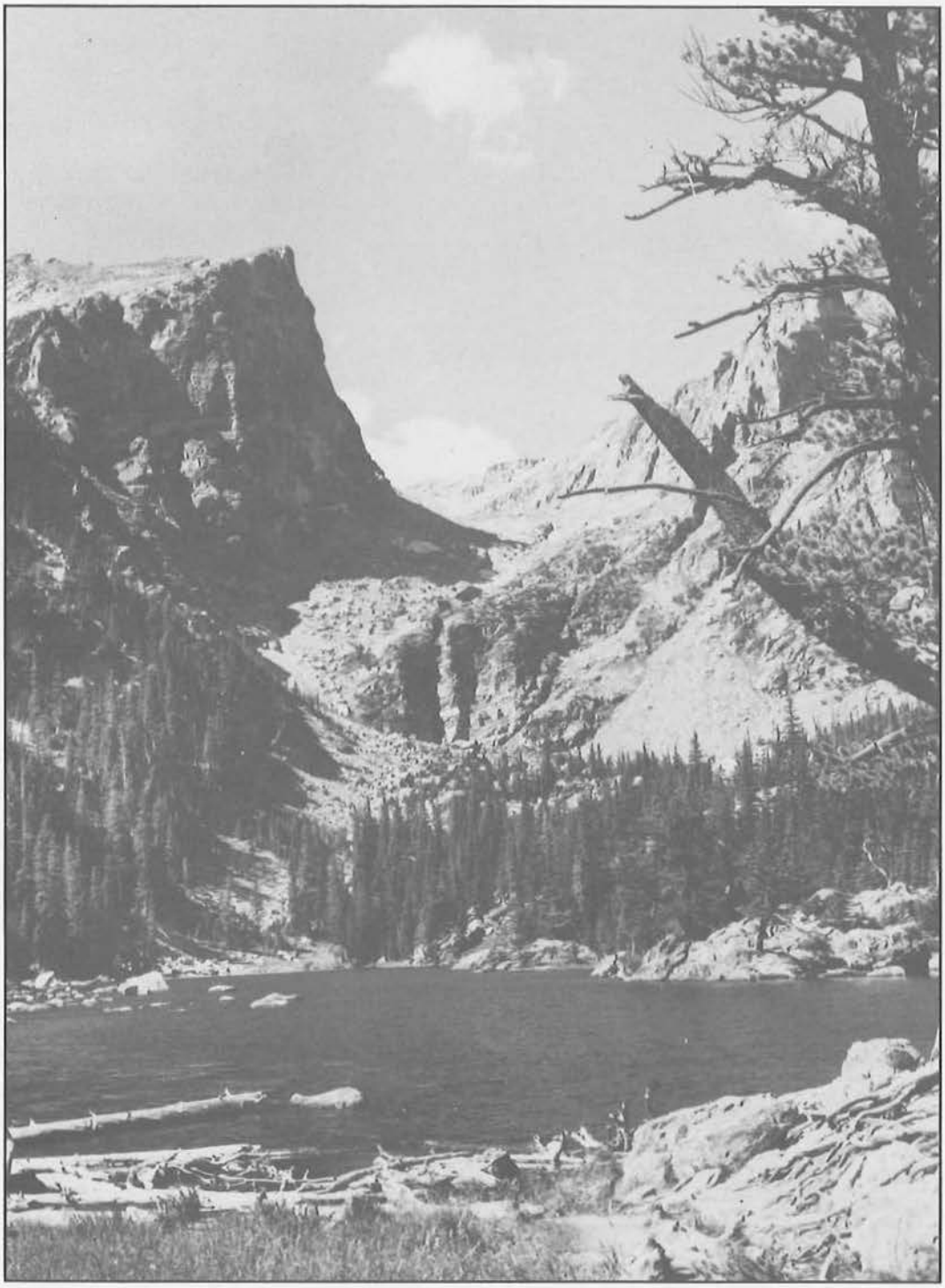
LTER NETWORK NEWS

Newsletter of the Long-Term Ecological Research Network

Fall 1990, Issue 8

IN THIS ISSUE:

All Scientists Meeting	3
H.J. Andrews site	4
North Temperate Lakes	5
Sevilleta site	6
LMER Program	8
Publications	14
Calendar	16



Location of LTER All Scientists Meeting, September 25-30, 1990: Dream Lake with Hallet Peak in the background, near Estes Park, Colorado. See Page 3 for details. (Photo: Rocky Mountain National Park)

LTER-USGS Program Proposed

The U.S. Geological Survey Water Resources Division (WRD) has proposed collaborative efforts with the LTER Network to conduct long-term intersite comparisons and evaluate the effects of climate change over a gradient of biome conditions, work already underway at several sites. Under the U.S. Global Change Research Program, the objective of the work would be to improve the understanding and prediction capability of especially surface water, groundwater, and soil moisture to changes in atmospheric conditions, and to provide the scientific basis for improving the representation of terrestrial hydrologic systems in fully coupled land-atmosphere models.

One part of the Survey's program in global change research is Water, Energy, and Biogeochemical Budgets (WEBB), an in-house program scheduled to begin in FY 1991 that will provide basic data collection, historical, and process-level studies at 13 sites.

The Water Resources Division's complementary strengths are in the areas of measurement and modeling of various aspects of the water budget, especially streamflow and groundwater; nutrient fluxes in aquatic systems; geochemical processes in streams, the unsaturated zone, and the saturated zone; and some aspects of aquatic ecology. Collaborative work of this kind has already been conducted with Konza Prairie

continued on page 7

Data Management

by Rudolf Nottrott

1990 Data Managers Workshop

The LTER Data Managers held their annual workshop in Snowbird, Utah, July 26-28, 1990 prior to the Ecological Society of America meetings. All 17 sites were represented. A unique aspect of the workshop was the large number of returning data managers. The low turnover in personnel this year is a positive indication of the strength of commitment to managing research information across the Network.

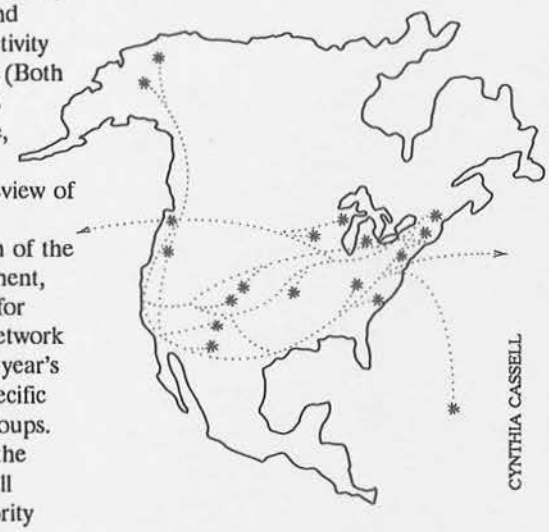
At the initial evening session, data managers gave short presentations on recent developments at their sites. Additional reports were given on the fall '89 and spring '90 LTER Coordinating Committee meetings, the KBS Workshop on Data Management at Inland and Coastal Field Stations, the Connectivity Report, the Core Dataset Catalog (Both text and on-line), the All Scientists Meetings, and the GIS Committee, among other topics.

The second day began with a review of the accomplishments of the 1989 workshop, followed by a discussion of the current state of site data management, and new directions and initiatives for LTER data management at the network level. Following the format of last year's workshop, participants selected specific issues for discussion in working groups. Results and recommendations of the groups were later synthesized by all participants into the following priority items and finalized in written reports:

- outreach to the larger ecological research community;
- an international symposium on issues of data management;
- a pilot project for an LTER climate database;
- a workshop on standardization issues related to GIS, remote sensing, and management of of ecological datasets.

Additional working groups focused on issues of proprietary rights and data sharing, packages for ecological databases, the use of networks in database management, managing metadata (i.e., descriptive data), sharing models and software, optical disk storage media, and intersite data exchange formats. Other tasks of the group were to outline an initial agenda for the 1991 Data Managers Workshop and identify a Data Managers Task Force for 1990. The 1990 Task Force: Barbara Benson, NTL; James Brunt, SEV; William Michener; Rudolf Nottrott, NET; John Porter, VCR; and Susan Stafford, AND.

Representatives from organizations outside the LTER Network gave presentations on the final day. John Pfaltz of the Institute for Parallel Computation, University of Virginia, spoke on the differences and commonalities between scientific and commercial databases. Walt Conley of the Department of Biology, New Mexico State University, discussed Parknet, the U.S. Department of Energy's (DOE) network of six ecological research sites, and suggested areas of possible cooperation with the LTER Network.



CYNTHIA CASSELL

A detailed report on workshop proceedings, with recommendations, will be available at the LTER All Scientists meeting in September.

Core Datasets Catalog

Work on the LTER Core Dataset Catalog is proceeding on schedule. The sites have submitted final drafts of their catalog entries to William Michener, coordinator of the effort. The final version of the Catalog will be available this fall both in hardcopy form and on-line at LTERNET.

Draft versions of the files representing the Catalog entries are already on-line at LTERNET both in ASCII text and WordPerfect format. They are in the public directory ~ftp/catalog. The possible access methods include anonymous file transfer (FTP) over the Internet (host, "lternet.washington.edu"; Internet address, "128.95.36.1"), with automatic mail reply for subsets of the files to be enabled later. The files are presently stored on a per-site basis. More files to be added shortly include a subject index, an investigator index, site abstracts and a reference guide.

Bulletin Board Now Accessible

VUI, the screen-oriented bulletin board for the new LTERNET Bulletin Board (see spring '90 *Network News*) is now publicly accessible. For detailed information on how to access and operate the bulletin board, send any message to:

"helpBB@lternet.washington.edu"
or "helpBB@lternet.Bitnet"

For more general assistance send any message to:

"help@lternet.washington.edu"
or"help@lternet.Bitnet"

continued, page 14

Network News

The *Network News* is published twice a year and distributed in limited quantities at no cost. Address queries to the editor: Stephanie Martin, LTER Network Office, University of Washington, College of Forest Resources AR-10, Seattle, Washington 98195, 206-543-6764.

LTER All Scientists Meeting

September 25-30, 1990 ● YMCA of the Rockies ● Estes Park, Colorado

Interest in the upcoming LTER All Scientists Meeting is still growing. At the close of registration in mid-August, over 275 attendees had confirmed and queries are continuing to come in to the LTER Network Office.

A large turnout is expected from each of the LTER sites, and attendance from ecologists outside the Network will be higher than at any LTER-sponsored event held thus far. Attending the meeting will be ecologists from the National Science Foundation Land-Margin Ecosystem Research (LMER) sites, the U.S. Department of Energy Parknet sites, the Environmental Protection Agency, the U.S. Geological Survey, the U.S. Forest Service, the National Science Foundation, and the National Academy of Sciences, as well as representatives from the Chinese Ecological Research Network (CERN) and the USSR Academy of Sciences.

The event begins with dinner and a slide presentation on Rocky Mountain National Park, followed by daily plenary sessions, work sessions and both formalized and ad-hoc workshops. Two optional field trips to the Mountain Research Station and the Niwot Ridge LTER site on travel-in and travel-out days (September 25 and September 30) have also been scheduled.

Major research topics were developed at the spring 1990 LTER Coordinating Committee meeting at the Luquillo LTER site in Puerto Rico to accomodate the varied interests and research activities across the Network. The work sessions and workshops (see box, this page) are organized according to four topics: "LTER in the '90s," "Global Change," "Biodiversity" and "Regionalization."

The first day, in addition to the plenary speakers scheduled, there will be a large, extended poster session with many posters on current research from both within and without the LTER Network. During this informal period, participants can discuss research and plan future collaborations. For the rest of the meeting, the workshops will be held after short morning plenary talks. There will also be ample free time in the afternoon and evening for ad-hoc workshops, discussions and meetings.

For more information contact John Vande Castle, Coordinator, LTER Network Office, University of Washington, College of Forest Resources, AR-10, Seattle, WA 98195, 206-543-4853, or via electronic mail at: "jvc@lternet" or "jvc@lternet.washington.edu". ■

Workshops & Work Sessions

- GIS Research & Modeling
- Soil Warming Experiments
- Atmospheric Chemistry
- Trace Gas Exchanges
- Paleoecology
- Decomposition
- Data Sharing in LTER
- Climate Committee
- GIS Working Group
- Modeling Working Groups
- Linkages to Other Networks
- Consumer Controls
- Biological Legacies in Ecosystems
- Invasions
- Megalandscape Experiments
- Catastrophic Events
- Dual Tracer & Root Turnover
- The Larger Ecological Community
- Systematics in the LTER Program
- Data Managers Committee
- Plant Morpohology in Plant
- Community Development
- Remote Sensing NDVI
- Landscape Processes
- Scaling
- Stream Processes
- Cross-site Analyses of Models
- Communications Networks
- Global Positioning Satellites

Plenary Speakers (partial list):

Caroline Bledsoe, BSR, NSF
Scientific Networking

Mary Clutter, BBS, NSF
Politics of Ecology

Jerry Franklin, Chair, LTER Network
LTER Past, Present & Future

Beryl Leach, National Academy of Sciences
Long-Term Ecological Research in China

Paul Risser, Sevilleta LTER
International Network & Global Ecology

Patricia Werner, BSR, NSF
Biodiversity & Ecosystem Function

H.J. Andrews Experimental Forest

by Frederick J. Swanson, Arthur McKee & Mark E. Harmon

Andrews Forest LTER enters its second decade with a flurry of research activity, facilities development, and extensive involvement with the forest management debate reverberating across the Pacific Northwest.

Decomposition

Several recent Andrews Forest research projects have concerned decomposition and change in carbon stores in terrestrial ecosystems. Using extensive vegetation data sets and analysis of the fate of carbon on the site and in logs leaving the site, Mark Harmon, Bill Ferrell, and Jerry Franklin modeled effects on carbon budgets of conversion of old-growth forests to intensively managed forests.

They found a net loss of 300 tons per hectare of carbon over the first 60 years after cutting. These calculations suggest that conversion from natural to managed forest in the conifer biome of the Pacific Northwest may account for 2+% of the increase in atmospheric CO_2 arising from all land use in the past century.

Mark Harmon has also managed the establishment of the LTER intersite litter decomposition experiment in which leaf litter of 25 species is exchanged among the 17 LTER sites plus four additional sites. This study has a 10-year design life and represents the first time that a full suite of site and experimental variables are collected in a coordinated fashion over such a broad array of environments and litter types. The information will be useful in modeling leaf and fine root decomposition on the global scale.

Cooperative Projects

Other recent research includes: a cooperative project with Dean Urban (University of Virginia) and the EPA Global Change Program to model the response of forests west of the crest of the Cascade Range to climate change

CYNTHIA CASSELL

using the gap model ZELIG; detailed analysis of spatial variability of soil (nitrogen, microbial biomass, invertebrates, etc.) and vegetation properties in natural forest stands of 100 and 500 year ages; modeling of the input of coarse woody debris to streams; and a cooperative project with U.S. Geologial Survey to model streamflow at a landscape scale.

New Personnel

Several post-docs recently joined the Andrews LTER project. Steve Hart (University of California, Berkeley) has been working with Dave Perry and Phil Sollins on nitrogen cycling in forest soil and decaying logs. Donna D'Angelo (Virginia Polytechnic Institute), who recently worked on nutrient cycling in streams at the Coweeta LTER site, is helping Stan Gregory and Gary Lamberti (University of Notre Dame) initiate a stream nutrient enrichment study designed for comparison with a similar study on the Kuparuk River at the Arctic Tundra LTER site.

Facilities Upgrade

Andrews LTER facilities are being substantially upgraded. Funds from the U.S. Forest Service and NSF will make it possible to replace several decrepit trailers with two 4,000-square-foot bunkhouses for researchers in the field. Oregon State University, NSF and Forest Service funds have supported installation of a Sun-based computing system, a local area network, and a GIS laboratory.

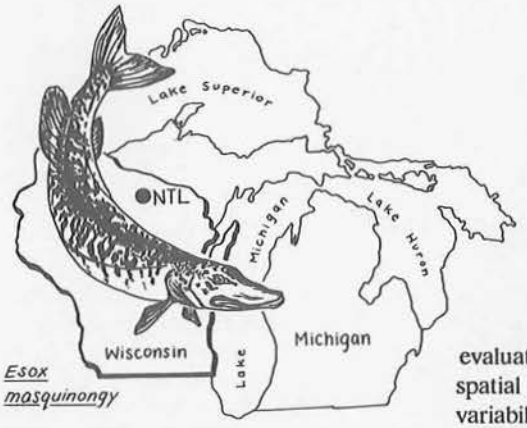
Results Gain Prominence

In the past year results and implications of Andrews-based research over the past two decades have gained great prominence through the current controversy over management of the remaining old-growth forest in the Pacific Northwest. Basic esoteric research topics of the 1970's and early 1980's, such as the ecology of old-growth forests and northern spotted owls, are major political and social issues in 1990. Andrews scientists and U.S. Forest Service land management colleagues have developed and implemented alternative approaches to management of forest stands, forest cutting patterns, and stream and riparian networks--practices which are based on the results of ecosystem research at both stand and landscape scales.

Site personnel now conduct nearly 100 tours a year to view examples of the spectrum from basic research studies to application on Forest Service lands. Audiences include members of Congress, other elected officials, their staffs, students, educators, land managers, and news media.

For additional information contact Fred Swanson or Art McKee, Forestry Sciences Lab, 3200 Jefferson Way, Corvallis, OR 97331. ■

North Temperate Lakes



CYNTHIA CASSELL

by Timothy K. Kratz & John J. Magnuson

North Temperate Lakes (NTL) LTER is entering its second decade of long-term ecological research. Although many of the major goals for the next decade are similar to those of the past 10 years, most have evolved to encompass broader spatial and temporal points of view.

Within the synthetic goal of understanding the ecological complexity generated by multiple processes acting over many temporal and spatial scales, broad-scale evaluations of factors controlling lake processes are being developed. These include:

- perception of long-term trends in physical, chemical and biological properties of lake ecosystems;
- understanding of dynamics of internal and external processes affecting lake dynamics;
- analyses of temporal responses of lake ecosystems to disturbance and stress;
- evaluation of interactions between spatial heterogeneity and temporal variability of lake ecosystems; and
- expansion of the understanding of lake-ecosystem properties to a broader, regional context.

The Northern Highland Lake District in northcentral Wisconsin provides the abundance and diversity of lakes necessary for such multi-scaled research.

Groundwater Scales

One of the most robust results in NTL's first decade of research is the recognition of the important role groundwater plays in providing the hydrologic and geochemical context of the lake district. To date, research has focused on understanding the role groundwater plays in individual lakes. In the next decade we will expand the spatial scale to develop a spatially-explicit, regional hydrologic model that will be driven by weather-related parameters. If successful, the model will allow the prediction of water levels and solute loading in lakes throughout the lake district as a function of weather. Thus far researchers have quantified the degree to which lakes behave similarly to each other through time. Findings show, for example, that lakes tend to behave similarly with respect to water levels, but independently with respect to a wide assortment of chemical and biological parameters. The temporal coherence of lakes with respect to water levels makes NTL researchers optimistic that they can successfully model hydrologic processes affecting lakes on a regional scale.

The temporal scale of NTL groundwater observations from years and decades has been expanded to millenia using the record stored in lake sediments. Analysis of fossil sponge spicules reveals a dramatic, but gradual, long-term decline in silica concentration in lakes throughout the lake district. Causes of the decline are not fully understood, but may involve diffential weathering of silicate tills during the Holocene. This result adds to the mounting evidence that systems are rarely in equilibrium, even when averaged over long time periods.

JOHN J. MAGNUSON

Crystal Lake, at the top of NTL's groundwater flow system, provides clear water and sandy beaches for tourists.

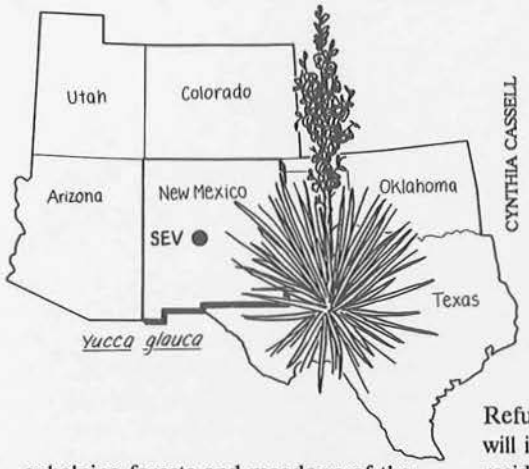
Intersite Spatial Analysis

The next major intersite research project will initiate comparisons of landscape structure of diverse sites using remotely sensed data to control for the spatial extent and grain of the data sets. Findings show grain of observation is important; for example, the area perceived to be covered by lakes in the lake district drops to half when the grain of observation is changed from 30-meter to 1-kilometer grids.

The remote sensing workshop at the LTER All Scientists Meeting this September will provide a first step for intersite interests in this area.

continued, page 14

Sevilleta



by Robert R. Parmenter

The University of New Mexico's (UNM) Sevilleta LTER has grown considerably in its second year of operation. The primary study site is the 400-square-mile Sevilleta National Wildlife Refuge, located 70 kilometers south of Albuquerque. The Sevilleta lies in the transition zone between four major biomes and contains extensive areas of short-grass prairie, Chihuahuan desert, Great Basin shrub-steppe and piñon-juniper woodland.

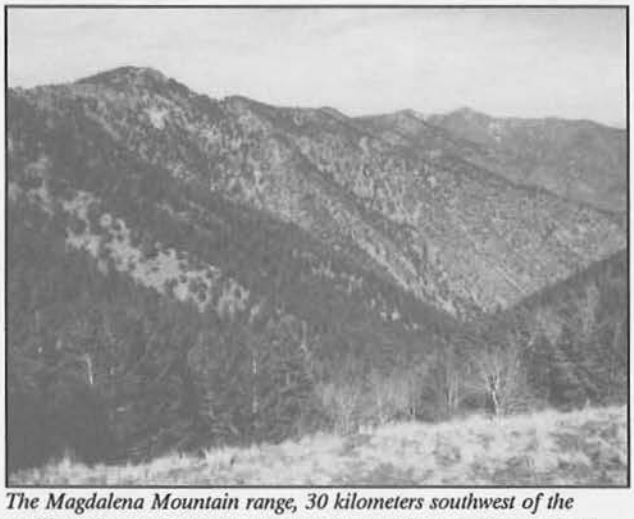
Site Expansion

In addition to the Sevilleta, the UNM LTER program has recently expanded its study sites to include the riparian cottonwood forests along the Río Grande at Bosque del Apache National Wildlife Refuge (elevation 4,500 feet), and the subalpine forests and meadows of the Magdalena Mountains (elevation 10,700 feet) in Cibola National Forest. Inclusion of these important ecosystems in the Sevilleta research will allow UNM scientists to analyze the effects of regional climate dynamics on biotas from a wider variety of New Mexico's habitats, ranging from hot, dry deserts to cool, moist forests. The addition of southwestern riparian and montane forests will also provide an increased opportunity for cross-site comparisons with other forested LTER sites.

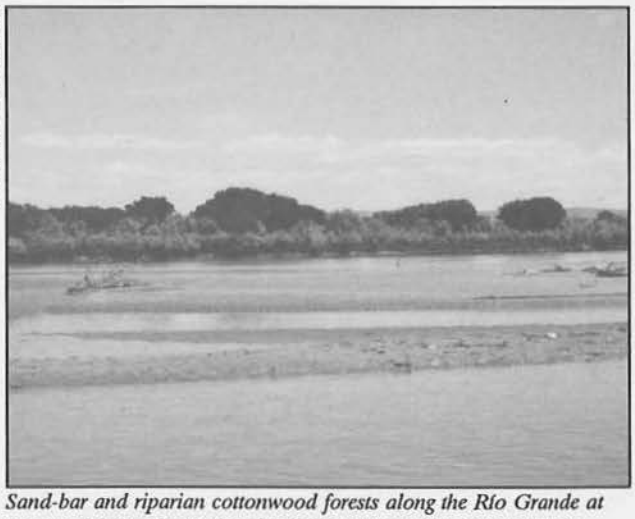
New Field Station

With a grant from the National Science Foundation (NSF), construction of a permanent field research station on the Refuge will begin this winter. The facility will include a laboratory/office complex, a residence hall for up to 20 scientists and students, and a dining hall/conference center. Cliff Crawford will be the Field Station Director, and Bob Parmenter the Station Manager. The field station, scheduled to open April 1, 1991, will provide much-needed logistical support to the large number of researchers working in the the Sevilleta and surrounding areas.

For additional information, contact Robert Parmenter, Biology Department, University of New Mexico, Albuquerque NM 87131. ■



The Magdalena Mountain range, 30 kilometers southwest of the Sevilleta National Wildlife Refuge, has extensive meadows and old-growth forests of Englemann Spruce, Douglas fir, subalpine fir, ponderosa and limber pine.



ROBERT R. PARMENTER

Sand-bar and riparian cottonwood forests along the Río Grande at Bosque del Apache National Wildlife Refuge, New Mexico. This refuge serves as a major overwintering site for thousands of migratory birds, including the Gray's Lake (Idaho) whooping crane population.

USFS Forest Health Monitoring Program (FHM)

In concert with the six New England states the U.S. Forest Service (USFS) has designed a national system to annually monitor the health of the Nation's forests as an integral part of the USFS Global Change Program proposed under the Forest Ecosystems and Atmospheric Pollution Research Act of 1988. The program involves coordination with the U.S. Environmental Protection Agency's Environmental Monitoring & Assessment Program (EMAP).

Currently, the Forest Service gathers data about the forest resource and its health in various ways, most notably, the periodic Forest Inventory and Analysis (FIA) surveys and specific insect and disease surveys the State and Private Forestry division of Forest Pest Management (FPM) coordinates through state forestry agencies or conducts on federal lands.

Forest Health Monitoring (FHM) will be a multi-tiered, long-term process to 1) detect unexpected deviation from established baseline conditions or trends, 2) identify causes of change, and 3) define basic relationships sufficiently to predict consequences. Three monitoring levels are planned, with each successive tier requiring progressively more detailed and costly information:

- **Detection monitoring.** A geographically-based network of permanent plots coupled with remote sensing pest surveys distributed throughout U.S. forests.
- **Evaluation monitoring.** When detection monitoring identifies areas or problems of concern, a multidisciplinary team will determine specific evaluation needs and undertake activities such as additional surveys, site or area-specific evaluations, and more detailed monitoring.
- **Research monitoring.** Monitoring at this level provides data for ecosystem research undertaken to better understand causal relationships and to predict rates of changes in forest condition.

Implementation of the FHM program began this year in New England where the Service and the six State Forest agencies are collecting the first year's data on approximately 250 detection monitoring plots. State foresters are providing the field cadre for this effort, and as forest health monitoring expands, it is expected that each state will provide the forestry personnel for the detection level plots each year, ensuring consistency and stability in the field observations.

Working with the EMAP, with adequate funding the Forest Service expects to fully implement the monitoring program over the next five years including efforts in the South and West. In September 1990, program representatives will be conducting a workshop at the LTER All Scientists Meeting in Estes Park, Colorado.

For more information, contact Joseph E. Barnard, National Coordinator, Southeastern Forest Experiment Station, P.O. Box 12254, Research Triangle Park, NC 27709. ■

"USGS-LTER," *from page 1*

LTER, and discussions are underway between WRD hydrologists and scientists at H.J. Andrews, Sevilleta, and the potential new Antarctic Dry Valleys LTER.

Since February, USGS district and research scientists have actively been seeking to initiate additional collaborative LTER relationships. At least five more sites have expressed strong interest in participating in a joint program.

For more information contact Robert M. Hirsch, Assistant Chief Hydrologist, Research & External Coordination, USGS/WRD, WGS-Mail Stop 436, Reston VA 22092. ■

"Data Management," *from page 2*

LTERNET Upgrade

LTERNET communications capacity has been upgraded. LTERNET is now connected via a nodal switching system directly to the NSFNET backbone, allowing Internet file transfers to and from LTERNET at maximum speeds up to the limit of 1.54 megabits/second.

The LTERNET dial-in connection has been upgraded to a 2400 bits/second (bps) reliable connection with error correction. With data compression, this allows file transfers at speeds close to 4800 bps. The modem will recognize the speed of the incoming connection and automatically adjust. For detailed instructions send any message to: "dial@lternet.washington.edu"

LMER Sites Join LTERNET

Three LMER sites have joined the LTERNET electronic mail forwarding system: Columbia River Estuary Turbidity Maxima (CRETM), Tomales Bay Biogeochemical Reactions in Estuaries (BRIE), and Waquoit Bay. To obtain a list of the individual researchers at these sites, send any message to: "groups@lternet.washington.edu" ■

The Land Margin Ecosy

Studying Ecosystems at th

For decades coastal ecosystems have been pervasively and substantia research in these systems seemed to fall through the cracks between th Ecosystems Research (LMER) program funded through the Biotic Syste Foundation (NSF), research on ecosystems at the land-sea interface has although they encompass different land-margin environments, take the u time scales (i.e., seasonal versus interannual with nutrient cycling and hyd estuaries of Chesapeake Bay in the Mid-Atlantic states, and the Columb British Columbia, to Tomales Bay, an intermediate-sized bay in a relativ lagoon in a forested and urbanized watershed in New England. The f the Marine Biological Laboratory in Woods Hole, Massachusetts, component to synthesize and coordinate research, and a clearly proposals will be considered this year. All LMER investigators en prior arrangements, some logistical support, vessel time, and

CHESAPEAKE BAY

Processes of Recycling, Organic Transformation and Exchange between Uplands and the Sea (PROTEUS)

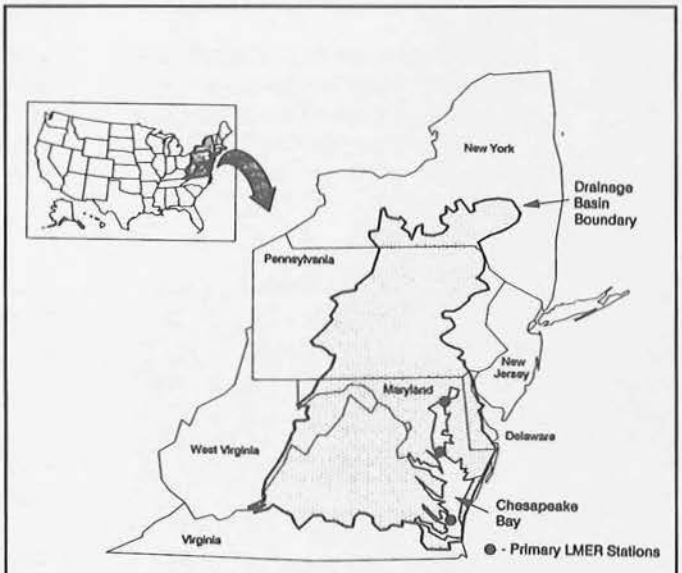
by W. M. Kemp and W. R. Boynton

The PROTEUS-LMER is focused on the complex dynamics of nutrient cycling in the Chesapeake Bay--one of the largest estuaries in the world, extending some 314 kilometers (km) along a north-south axis and ranging from 6 to 56 km in width. The Bay has a mean depth of 8.5 meters, with a channel ranging from 10-50 meters depth running along its length. Its watershed covers an area of approximately 166,000 km^2, draining piedmont and coastal plain provinces of three states: Pennsylvania, Maryland and Virginia.

There are approximately 12.7 million people inhabiting the Chesapeake Bay watershed, and most of the major population centers are located on the shores of the estuary and its tributaries. Over 60% of the land in the basin is still forested, while croplands, pastures and urban-residential areas comprise about 20, 10 and 15%, respectively, of the land uses in the watershed. From 1950 to 1980, human populations in the basin increased by two-thirds; nutrient inputs to the Bay from sewage effluents and agricultural runoff in the watershed nearly doubled. In addition to the long-term trends in annual loadings of nitrogen (N) and phosphorus (P) to the estuary, a relatively large interannual variablity in loadings occurs in relation to fluctuating hydrological factors.

Research Design

The NSF LMER project, which was initiated for Chesapeake Bay in the fall of 1988, has four research components: 1) data collection in the water column (or pelagic) habitat; 2) data collection in the sediment (or benthic) habitat; 3) observations on physical circulation; and 4) modeling of physical and ecological processes.



DRAINAGE BASIN OF CHESAPEAKE BAY

Field studies consist of a core program in which seasonal and interannual variations in basic nutrient and related ecological conditions are characterized for the Bay's three main salinity provinces (oligohaline, mesohaline and polyhaline), and a special focus program in which detailed analyses are concentrated on a particular spatial or temporal dimension of the Bay's nutrient cycling/organic production system. The overall research program relies heavily on computer-based simulation modeling studies of ecological and physical processes as a means to effectively integrate the diverse components of the research into a unified ecosystems perspective.

Significant correlations between inputs of N and, to a lesser extent of P, and phytoplankton production have been observed for Chesapeake Bay and other estuaries. These data suggest the interesting possibility that production per unit nutrient input is generally greater for Chesapeake Bay than for most other coastal systems. PROTEUS researchers have hypothesized that this feature is related to physical circulation mechanisms which promote nutrient retention and ecological mechanisms which, in turn, effect efficient nutrient recycling. Indeed, indirect evidence indicates that these nutrient retention and recycling mechanisms are operating on seasonal as well as interannual time scales.

Preliminary Results:

Preliminary input-output budgets for N, P, and silicon (Si) in Chesapeake Bay suggest several interesting results. In the

continued on page 12

ystems Research Program

he Interface of Land & Sea

ially altered, principally by human activities in watersheds. Until recently, the pure terrestrial and "blue water" oceanography. Under the Land Margin ems and Resources and the Ocean Sciences divisions of the National Science as begun at four sites which are widely distributed geographically and which, unifying approach of examining dynamics of ecosystem processes on different yd periods with turbidity maximum dynamics). The sites range from the large bia River, whose watershed extends into several Pacific Northwest states and ively dry agricultural California watershed, and Waquoit Bay, a small shallow first two rounds of proposals, which grew out of a 1987 workshop held at emphasized the incorporation of novel technologies, a strong modeling y defined scientific and administrative coordination. A third round of ncourage cooperative research proposals by external investigators; with nd access to laboratory and housing facilities can be provided.

COLUMBIA RIVER ESTUARY

ETM Dynamics and the Impact of Anthropogenic Change

by Charles A. Simenstad & David A. Jay

IN LANDSCAPE ecology terms, the Columbia River Estuary Turbidity Maxima (CRETM) LMER studies focus on the "relay node" at the estuarine land-sea interface, the bottleneck of the ecosystem. This is where localized physical, geochemical and biological processes transform and redistribute organic constituents borne by the river through the estuarine food web and adjacent coastal waters. In river-dominated estuaries such as the Columbia, these processes pivot around the dynamics of the estuarine turbidity maximum (ETM), where non-linear tidal and residual circulation processes promote trapping and increased residence of inorganic and organic particulate matter.

The CRETM-LMER studies were initiated in late spring 1990 and will continue through fall 1994. The nine-investigator team from the University of Washington, Oregon State University and Louisiana University Marine Consortium are investigating the comprehensive hypothesis that ETM processes promote and control microbial conversion of entrapped organic matter and facilitate maintenance of dense populations of primary consumers, which exploit the microbial loop for food. Nutrient cycling, particularly nitrogen transformations, is also believed to be concentrated in the ETM. CRETM-LMER researchers are further testing the hypothesis that organic matter generated through the watershed landscapes and transported into and down river continua is not necessarily exported directly and exclusively to coastal waters; rather, the estuarine food web captures a significant portion of these terrestrial organics when ETM are active.

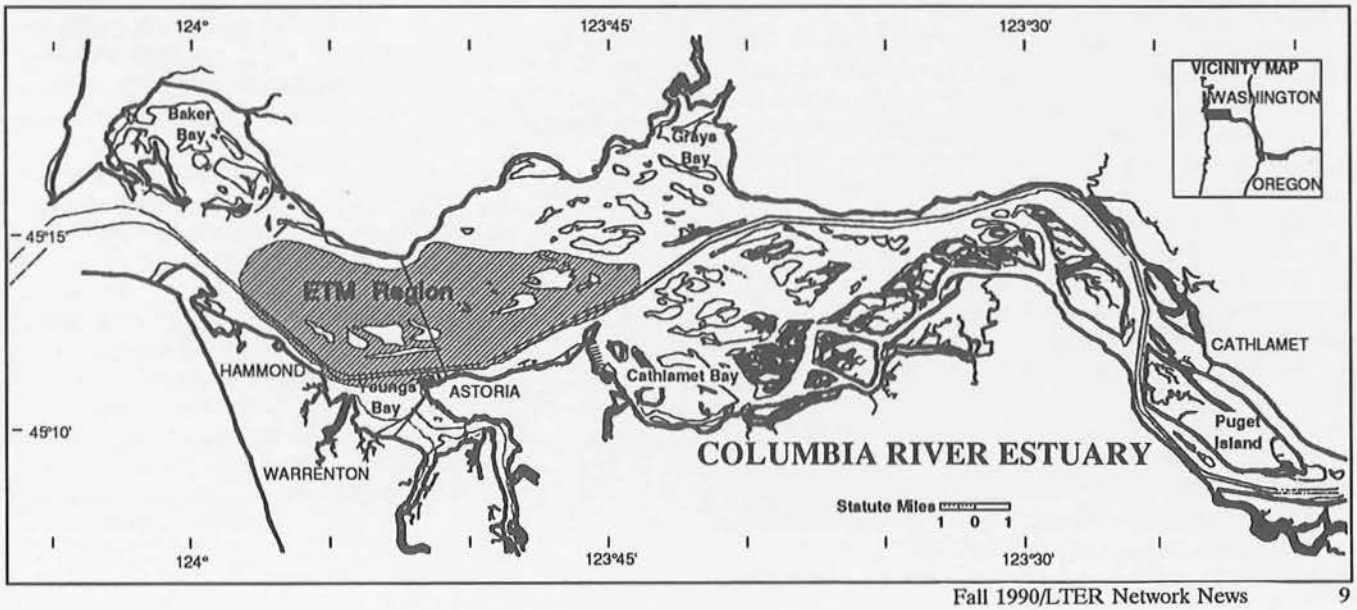
Site Characteristics

As LTER and LMER sites go, the ecosystem toward which the CRETM studies are directed is a landscape of colossal scale--660,480 kilometers^2. The Columbia River and estuary "site" was selected because 1) it has a prominent ETM of established importance to the estuarine food web; 2) the basic physical processes that drive the ETM are better understood here than in most estuaries; 3) it is representative of numerous river estuaries throughout the world having ETM; and 4) anthropogenic changes in river inflow and tidal prism are well-documented, allowing model prediction of the influence on ETM of these and potential future changes, and subsequent impacts to the land-margin ecosystem.

Sampling Design

Because the ETM varies spatially and over a range of temporal scales, from intertidal to climatic regimes, the research team needed to identify dominant, representative scales. Circulation in the estuary is typified under three conditions which account for the bulk

continued on page 12



TOMALES BAY
Biogeochemical Reactions in Estuaries (BRIE)

by S. V. Smith and J. T. Hollibaugh

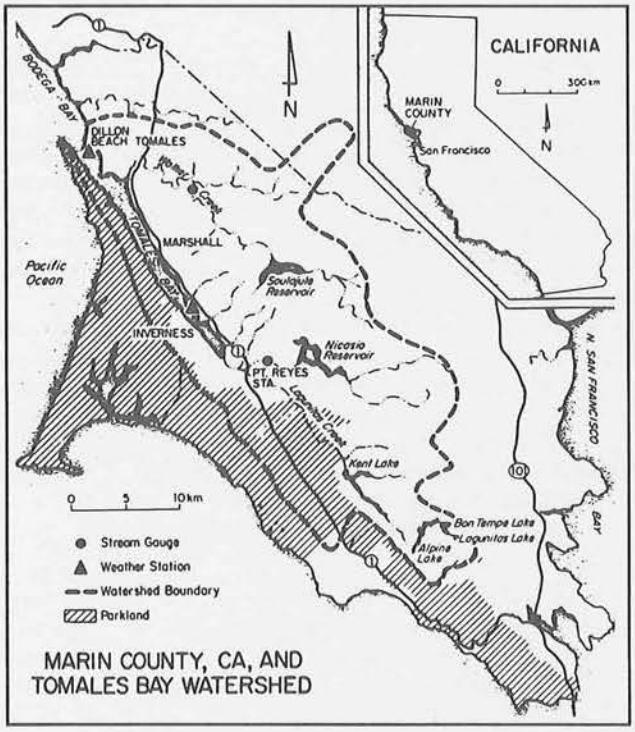
TOMALES BAY, which lies about 50 kilometers (km) northwest of San Francisco in a rift valley formed by the San Andreas Fault, has been chosen as a site to study whole-system land-estuary-ocean exchanges and net biogeochemical reactions. Materials of primary interest are the nutrient elements carbon (C), nitrogen (N), and phosphorus (P). The linear shape of the Bay (20 km long by 1.4 km wide), its well-defined freshwater inflow, and simple water exchange are readily described with a one-dimensional circulation model. Water exchange is slow during most of the year, and net chemical reactions in the Bay alter water composition substantially. Despite the simple hydrologic and hydrographic regimes of this system, biotic community structure and biogeochemical function appear typical of North American Pacific Coast estuaries.

Site Characteristics

Despite its proximity to a large urban area, the 560-km^2 Tomales Bay watershed has a population density of only about 20 persons/km^2. Unlike many North American estuaries, water discharge to Tomales Bay has not been greatly disrupted by human intervention. The Bay receives low input of dissolved pollutants. Fishing pressure on the system is also low. The major human perturbation which has affected this system is that replacement of native vegetation by introduced grasses and extensive grazing have apparently increased sediment discharge to the Bay.

Marine research in Tomales Bay dates back to the late 1940's, when the Pacific Marine Station was built near the mouth of the Bay. With the closing of that laboratory in 1979, study of the Bay decreased. Then in 1985, cooperative research efforts by San Francisco State University, the U.S. Geological Survey, and the University of Hawaii rekindled scientific interest. In 1987-88, a one-year NSF-funded study of the nutrient dynamics over an annual cycle was begun. That study was extended through a second year, on the assumption that a two-year drought would break and alter the input of terrigenous materials.

It became increasingly apparent that Tomales Bay was ideally suited for long-term studies of responses of an estuarine ecosystem to material exchanges with the land and ocean. The BRIE-LMER program was funded in October 1989 and has provided continuation of the bimonthly analysis extending back to June 1987.



Approach & Methodology

BRIE-LMER research on the Tomales Bay ecosystem can be divided into seven major components: 1) analysis of nonconservative fluxes of the nutrient elements C, N, and P, based on hydrographic surveys and material budgets; 2) sedimentation analysis, both from radiometric age dating of cores and from estimating suspended load delivery by streams; 3) analysis of circulation and the effects of coastal upwelling, based on physical oceanographic studies; 4) C, N, and P cycling through major biotic components of the ecosystem, from field and laboratory experimentation; 5) evaluation of sites and controls of nitrogen fixation and denitrifi-cation, based on field and laboratory experimentation; 6) modeling of terrigenous and marine contributions to nutrient fluxes; 7) ecosystem modeling of biogeochemical C, N, and P cycling, and the controls on that cycling.

Preliminary Results:

Dissolved nutrient concentrations in the Bay appear more strongly related to regeneration from particulate material than to dissolved nutrient delivery. The system exports more dissolved P than it imports, while dissolved N import exceeds export. The interpretation being tested with smaller-scale experiments is that net organic oxidation releases dissolved P, while net denitrification consumes dissolved N. If this interpretation is correct, then there must be some external source of particulate organic matter supporting these fluxes. Two processes seem to account for most particulate organic delivery: runoff and tidal input of the products of coastal upwelling.

Rainfall and runoff are almost entirely confined to the months November-April. Rainfall records at one site date back to 1876. That period shows strong inter-annual variations and long-term trends in rainfall. The bay-wide sedimentation rate between 1850 and 1950 was approximately 8 millimeters/year, based on mapped changes in bay water depth. Most sedimentation is apparently associated with land-derived input, with little sediment escape to coastal ocean.

continued, page 13

WAQUOIT BAY
Coupling of Watersheds and Coastal Waters

by Ivan Valiela

LMER RESEARCHERS are taking a whole-ecosystem approach to the study of Waquoit Bay on Cape Cod, Massachusetts, to assess how increased deforestation and urbanization may lead to greater nutrient loading from watersheds to adjoining coastal waters. This shallow bay (maximum depth 2.7 meters) is protected by barrier beaches. As in many similar lagoons or bays, groundwater is the major source of freshwater-borne nutrients.

About 12%, or 630 hectares, of the Waquoit Bay hydrologic system is covered by estuarine waters. Together the seven sub-watersheds total 4,619 hectares; the total area of land and water in the watershed is 5,366 hectares.

Waquoit Bay was designated a National Oceanic and Atmospheric Administration (NOAA) National Estuarine Research Reserve (NERR) in 1987 because of its location, regional importance, and potential for research. The NERR management plan fosters both conservation and research activities, and coordinates with state initiatives to purchase land and implement regulations to protect the Bay and selected sub-watersheds. NOAA-NERR research on Waquoit Bay has provided the background data for the LMER studies.

Coupling Terrestrial & Marine Components

The structure of the Waquoit Bay-LMER studies is based on the identification of sub-watersheds that have undergone different degrees of development, as well as adjoining sub-estuaries that receive nutrient loadings from these sub-watersheds. A series of hypotheses about the nutrient dynamics in terrestrial and marine parts of the coastal landscape are being tested, as well as the effects of inputs from watersheds and tidal flushing on key biotic components of the marine ecosystem.

The terrestrial components of the program involve measuring and modeling 1) inputs of nutrients into each of the sub-watersheds, 2) nutrient storage and transformations within both the sub-watersheds and aquifers, and 3) transport and attenuation of nutrients in groundwater and streams.

Coupling of the marine components to the sub-watersheds involves measuring and modeling 4) the release and transformation of nutrients as they pass from the watershed across the sediment-water interface and into coastal ecosystems, 5) the effects of hydrographical features on nutrient supply and turnover rates, and 6) the influence of nutrient supply on the productivity of macroalgae, eelgrass, phytoplankton and benthic algae. Inputs to the ecological model are designed to operate at decade, monthly and tidal time scales. These various models will be used to examine hypotheses, structure measurements to verify the models, synthesize various data, and describe how coupled watersheds and coastal waters operate.

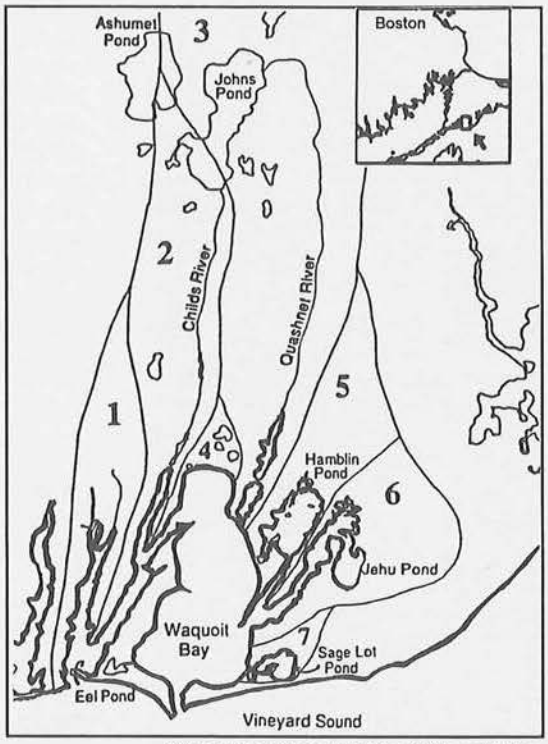
Approach & Methodology

Mass balance measurements are being taken of nutrient fluxes onto watersheds, transformations by vegetation and soil, transport into and within groundwater, and flux through subtidal sediments into overlying water. The effects of these fluxes of nutrients on oxygen content of water, on nutrient transformations, transport, and release in the sub-estuaries, and on the primary producers (macroalgae, phytoplankton, seagrasses) are being studied, as well as the role of tidal flow, bathymetry, and stratification in transport, supply, and loss of nutrients. A variety of research techniques is being employed, including Geographical Information Systems (GIS) and natural stable isotopes, along with more traditional field and laboratory measurements. The research program includes ecological, hydrological and hydrographical models, manipulative experiments, and field measurements to investigate how changes in the land use and vegetation mosaic of coastal watersheds are coupled to changes in nutrient dynamics and primary production in shallow coastal ecosystems. Because the inputs to these models are the pervasive changes altering coastal zones, it is expected that the models --and the related research results-- will provide good tools for examining applied aspects of nutrient loading and water quality.

Preliminary Results:

Work done in similar bays, and current work in Waquoit Bay, shows that there are strong seasonal fluctuations in

continued on page 12



The seven sub-watersheds of Waquoit Bay.

"Chesapeake Bay," from page 8

case of N, for example, over 80% of the total inputs to the Bay arise from runoff and other diffuse "non-point" sources, while only 12% come from municipal and industrial "point" discharges. Direct precipitation of acid rain onto the Bay surface contributes 5% of the total. Burial in sediments accounts for less than 10% of inputs; 3% of the N inputs are removed from the Bay via fish harvests, thereby emphasizing the direct dependency of fisheries on inputs of new N. Although denitrification results in N losses equivalent to about 50% of the inputs for other estuaries studied in recent years, the process accounts for only 20% of N inputs in Chesapeake Bay. This apparently results from inhibitory effects of seasonal anoxia in this eutrophic ecosystem. Thus, almost 70% of the total N inputs are unaccounted for and, it is hypothesized, exported to the sea at the Bay mouth. Most of the P and Si appear to be similarly exported.

Currently, PROTEUS researchers are using combined hydrographic-ecological models to improve estimates of nutrient export on annual time scales. The large unaccounted-for fraction of nutrient inputs also raises the question of how the Bay ecosystem can be so retentive of and responsive to interannual variations in nutrient inputs from the watershed if most of these nutrient inputs are being exported to the sea.

It is postulated that nutrients entering the estuary from its watershed are retained for a sufficient period to be used, transformed and reused in a sequence of processes which support the system's rich organic production, before being exported to the sea in relatively refractory (dissolved and particulate organic) forms. The details of these processes, as well as how they are affected by changing rates of nutrient inputs, remain open questions.

For more information contact W.M. Kemp, University of Maryland, Horn Point Environmental Laboratories, P.O. Box 775, Cambridge MD 21613; or W.R. Boynton, Chesapeake Biological Laboratory, P.O. Box 38, Solomons MD 20688. ■

"Columbia River," from page 9

of ETM variability in the Columbia River estuary: 1) low flow, neap tide; 2) low flow, spring tide; and 3) high flow, spring and neap tide. Collectively, these include most of the ETM trapping mechanisms found in shallow estuaries. The sampling design is based on simultaneous physical and biological measurements over tidal, tidal-monthly and seasonal time scales. Thus, the unifying concept of the CRETM-LMER project is the physical characteristics of the ETM that determine the efficiency of the food web's interception of terrestrial and riverine organic matter. The latter are determined principally by the river flow and tidal amplitude.

Measurements indicative of ETM processes are: 1) riverine and oceanic inputs of living and detrital carbon and inorganic material; 2) settling velocities of particles, and turbulent and tidal fluxes of water, salt and sediment that determine the fluid mechanical trapping mechanisms creating the ETM; 3) *in situ* production of organic matter by ETM phyto-plankton; 4) geochemical determination of the origins and fates of organic matter (particulate and dissolved) imported to the ETM and its food web; 5) biomasses, sizes and growth and ingestion rates of microorganisms (bacteria, protozoa); 6) biomasses and ingestion rates of key epibenthic and epipelagic metazoan consumers (i.e., calanoid and harpacticoid copepods); and 7) ecology and behavior of these consumers relative to the ETM flow field.

Approach & Methodology

A combination of state-of-the-science hydrodynamic and ecological models and analytical techniques is being applied. These will include determining primary production and dissolved carbon into the ETM and measuring tidal and turbulent water, salt, and sediment fluxes using two connectivity temperature density meters (CTDs), an acoustic Doppler current profiler, and a boundary layer frame equipped with fast-response current meters and optical backscatter sensors. Water characteristics and constituents will be sampled with a high volume pump system operating concurrently in time and space with the circulation and sedimentation measurements.

Geochemical markers (stable isotopes, cupric oxidation products and lipids) will be used to identify the sources of organic matter to the ETM and follow the conversion of organic carbon through chemical and microbial processes to primary consumers. Bacterial and protozoan biomass and bacterial activity and the zooplankton that graze upon this "microbial loop" will be measured at sequential stages in the detrital pathway. These processes will be integrated via a circulation/suspended sediment transport model with a process-oriented ecosystem model to provide predictions of the impact of watershed and estuarine ecosystem change on ETM processes.

For more information contact Charles A. Simenstad, Fisheries Research Institute, WH-10; or David A. Jay, Geophysics Program, AK-50, University of Washington, Seattle, WA 98195. ■

● New LMER Sites to be Selected

NSF has announced an open competition for LMER Program funds up to $2 million--for potentially two to five new projects. Proposals are due January 4, 1991 and awards will be announced July 1. New projects will commence not earlier than September 1, 1991.

For more information, request Brochure # 90-92 or contact James Callahan, Ecosystem Studies Program, Division of Biotic Systems and Resources, Room 215, NSF, 1800 G Street, Washington, D.C. 20550.

● Proposed "Network" Workshop

A fall 1990 meeting of the four LMER sites to address issues of interite coordination has been proposed to NSF. Michael Kemp, principal investigator (PI) of the PROTEUS LMER, has developed a preliminary schedule for a workshop to consider formalizing and quantifying a comparative, intersite perspective among LMER sites, possibly in conjunction with or based on the model of the LTER Network.

The idea for the workshop grew out of discussions between the four LMER PIs at the LTER Coordinating Committee meeting at San Juan, Puerto Rico, in May 1990. This was their first opportunity to meet and discuss common interests and concerns, and to observe the operations of a large research network.

Two Harvard Forest LTER Experiments Planned

Two experimental manipulations planned at Harvard Forest for October 1990 include a simulated blowdown of approximately 1 hectare of mixed hardwood forest and selective mortality of red oak and red maple canopy trees in adjoining sites in the same forest.

The experiments are designed to simulate the impact of a catastrophic wind and the effect of a selective pathogen (e.g., chestnut blight), respectively. Red oak and red maple are the dominant species in these forests and they differ substantially in litter quality. Thus the removal experiment will also focus on long-term ecosystem changes resulting from the loss of contrasting important tree species.

These experiments will be the focus of long-term studies by all members of the research group at Harvard Forest LTER, covering areas ranging from micro-meteorology and ecophyisiology to trace gas analysis. Funding is provided by NSF and HFR operational funds.

For more information, contact David R. Foster, Harvard Forest, Harvard University, Petersham MA 01366. ■

LMER Sites:

***'Tomales Bay,'** from page 10*

Coastal upwelling occurs along much of the Pacific Coast in response to periods of strong, persistent northwesterly winds. While such conditions can occur anytime during the year, they occur most frequently April through September. There is more than a twofold interannual variation in upwelling intensity, with the period of study showing about average conditions in comparison to about 45 years of data. Coastal upwelling elevates dissolved nutrient concentrations at the Bay mouth. However, the major effect of this upwelling is probably related to particulate, rather than dissolved, fluxes. Presumably, primary production of the coastal ocean is enhanced by elevated nutrients, leading to the delivery of increased particulate organic detritus to the Bay.

Biogeochemical reactions in this system are affected by variable inputs from adjacent terrestrial and marine environments. Lessons learned about ecosystem responses to variable inputs in relatively small, tractable ecosystems like Tomales Bay can be extended to larger and more complex ecosystems.

For more information, contact J.T. Hollibaugh, Tiburon Center, San Francisco State University, P.O. Box 855, Tiburon CA 94920; or S.V. Smith, Department of Oceanography, University of Hawaii, Honolulu HI 96822. ■

***'Waquoit Bay,'** from page 11*

nutrient content in the water column. Observations in hand suggest that changes in nutrients entering bays, perhaps caused by mechanisms in watersheds, seasonally alter N:P entering coastal waters and change the identity of the nutrient that limits primary production. Four potentially important changes or effects have been recorded: 1) somewhat elevated dissolved nutrient content, 2) greatly increased macroalgal growth, 3) reduced eelgrass growth, and 4) effects of vegetation changes on benthic fauna.

Increases in nutrient loading are the most influential and widespread of these alterations to the coastal margin: there are signs of nutrient enrichment in the vast majority of coastal embayments or lagoons observed worldwide. The effects of such enrichment are more intense in shallow water bodies so that, in a sense, lagoons such as Waquoit Bay may be giving us a preview of the future for deeper, more energetic water bodies with faster water renewal.

For more information contact Ivan Valiela, Boston University Marine Program, Marine Biological Laboratory, Woods Hole MA 02543. ■

Luquillo Experimental Forest Field Trip-May'90, Puerto Rico

CHARLES A. SIMENSTAD

***Top:** John Magnuson (NTL) inspects large freshwater shrimp under study at the Bisley watersheds.* ***Bottom:** Leaf litter analysis at Bisley (right) and El Verde forests after Hurricane Hugo showed 10,000 stems/hectare. Epiphytes, exposed to 10 times the level of radiation, turned red. (L to R: Les Viereck (BNZ), Rudolf Nottrott)*

Publications

Some recent LMER site (see page 8) publications are included below.

Aber, J.D., J.M. Melillo and C.A. McClaugherty. 1990. In press. Predicting long-term patterns of mass-loss, nitrogen dynamics and soil organic matter formation from initial litter chemistry in forest ecosystems. *Canadian Journal of Botany.*

Aber, J.D., K.J. Nadelhoffer, P. Steudler and J.M. Melillo. 1989. Nitrogen saturation in northern forest ecosystems. *BioScience* 39:378-386.

Aber, J.D., C.A. Wessman, D.L. Peterson, J.M. Melillo and J.H. Fownes. 1989. Remote sensing of litter and soil organic matter decomposition in forest ecosystems. In: Mooney and Hobbs (eds.), *Remote Sensing of Biosphere Functioning*, pp. 87-103.

Bowden, R.D., P.A. Steudler, J.M. Melillo and J.D. Aber. Annual nitrous oxide fluxes from temperate forest soils in the northwestern United States. *Journal of Geophysical Research* (submitted).

Ells, R. Electronic networks are a boon to ecological research projects. *Windows on Computing*, No. 5. May/June 1990, pp. 4-6. University of Washington Computing and Communications, Seattle, Washington.

Finnie, T.C., C.D. Tomlin, J. Bossler, D. Cowen, B. Petchenik, H. Thomas, T. Wilbanks, J. Estes. 1990. *Spacial data needs: the future of the national mapping program.* National Academy Press, Washington, D.C.

Foster, D.R. and E. Boose. 1990. Long-term vegetation dynamics and disturbance history of a *Tsuga*-dominated forest in central New England. *Ecology* (submitted).

Foster, D.R., P.K. Schoonmaker, S.T.A. Pickett. 1990. Insights from paleoecology to community ecology. *Trends in Ecology and Evolution* 5:119-122.

Hollibaugh, J.T., et al. 1988. Tomales Bay, California: a 'macrocosm' for examining biogeochemical coupling at the land-sea interface. *Eos* 36: 843-845.

Gosz, J.R. and P.J.H. Sharpe. 1989. Broad-scale concepts for interactions of climate, topography, and biota at biome transitions. *Landscape Ecology* 3:229-243. Sevilleta LTER Publcation No. 2.

Grant, G.E., F.J. Swanson, M.G. Wolman. 1990. Pattern and origin of stepped-bed morphology in high-gradient stream, western Cascades, Oregon. *Geol. Soc. Amer. Bull.* 102:340-352.

Jay, D.A. In press. Residual barotropic flow variability in the Columbia River estuary. *Estuaries.*

Jay, D.A. In press. Estuarine salt and sediment balances: a Lagrangian approach. *Est. Coastl. Shelf Sci.*

Jay, D.A., and J.D. Smith. In press. Circulation, density structure and neap-spring transitions in the Columbia River estuary. *Prog. Oceanogr.*

Jay, D.A., B.S. Giese, and C.R. Sherwood. In press. Columbia River estuary: energetics and sedimentary processes. *Prog. Oceanogr.*

Jones, K.K., C.A. Simenstad, D.L. Higley, and D.L. Bottom. In press. Structure, distribution, and standing crop of benthos, epibenthos, and plankton in the Columbia River estuary. *Prog. Oceanogr.*

Lara-Lara, J.R., B.R. Frey, and L.F. Small. 1990. Primary production in the Columbia River estuary: I. Spatial and temporal variability of properties. *Pac. Sci.* 44:17-37.

Lara-Lara, J.R., B.R. Frey and L.F. Small. 1990. Primary production in the Columbia River estuary: II. Grazing losses, transport, and a phytoplankton carbon budget. *Pac. Sci.* 44:38-50.

Louis, I., S. Racette and J.G. Torrey. 1990. In press. Occurrence of cluster roots on *Myica cerifera (Myicaceae)* in water culture in relation to phosphorus nutrition. *New Phtol.*

McNulty, S.G., J.D. Aber, T.M. McLellan and S.M. Katt. 1990. Nitrogen cycling in high elevation forests of the U.S. in relation to nitrogen deposition. *Ambio* 19:38-40.

Melillo, J.M., J.D. Aber, A.E. Linkins, A. Ricca, B. Fry and K. Nadelhoffer. 1989. Carbon and nitrogen dynamics along the decay continuum: Plant litter to soil organic matter. In: M. Clarholm and L. Bergstrom (eds.), *Ecology of Arable Land*, pp. 53-62. Kluwer Academic Publishing, Dordrecht, Netherlands.

Melillo, J.M., P.A. Steudler, J.D. Aber and R.D. Bowden. 1989. Atmospheric deposition and nutrient cycling. In: Andreae, M.O. and D.S. Schimel (eds.), *Exchange of Trace Gases Between Terrestrial Ecosystems and the Atmosphere.* John Wiley and Sons, New York.

Molles, M.C., Jr., and C.N. Dahm. 1990. El Niño, La Niña and North American Stream Ecology. *Journal of the North American Benthological Society* 9:68-76. Sevilleta Publication No. 7.

Morrison, P.H., F.J. Swanson. 1990. *Fire history and pattern in a Cascade Range landscape.* USDA Forest Service Gen. Tech. Rpt. PNW-GTR-254. 77 p.

Oberdorfer, J.A., M.A. Valentino, and S.V. Smith. In press. Groundwater contribution to the nutrient budget of Tomales Bay, California. Biogeochemistry.

Perry, D.A. and others (eds.). 1989. *Maintaining the long-term productivity of Pacific Northwest forest ecosystems.* Timber Press, Portland, OR. 240 p.

Raich, J.W., R.D. Bowden and P.A. Steudler. 1990. In press. Comparison of two static chamber techniques for determination of CO_2 efflux from forest soils. *Journal of Soil Science Society of America.*

Schoonmaker, P.K. and D.R. Foster. 1990. In press. Some implications of paleoecology for contemporaory ecology. *Botanical Review.*

Sherwood, C.R., D.A. Jay, R.B. Harvey, P. Hamilton, and C.A. Simenstad. In press. Historical Changes in the Columbia River estuary. *Prog. Oceanogr.*

Simenstad, C.A., L.F. Small, C.D. McIntire, D.A. Jay, and C.R. Sherwood. In press. An introduction to the Columbia River estuary: brief history, prior studies, and the role of the CREDDP Studies. *Prog. Oceanogr.*

Simenstad, C.A., D.C. McIntire and L.F. Small. In press. Consumption processes and food web structure in the Columbia River estuary. *Prog. Oceanogr.*

Small, L.F., C.D. McIntire, K.B. Macdonald, J.R. Lara-Lara, B.E. Frey, M.C. Amspoker and T. Winfield. In press. Primary production, plant and detrital biomass, and particle transport in the Columbia River estuary. *Prog. Oceanogr.*

Smith, S.V., and J.T. Hollibaugh. 1989. Carbon-controlled nitrogen cycling in a marine 'macrocosm': an ecosystem-scale model for managing cultural eutrophication. *Marine Ecology--Progress Series* 52: 103-109.

Smith, S.V., J.T. Hollibaugh, S.J. Dollar, and S. Vink. 1989. Tomales Bay, California: a case for carbon-controlled nitrogen cycling. *Limnol. Oceanogr.* 34: 37-52.

Sipe, T. 1990. Gap partitioning among maples (*Acer*) in the forests of central New England. PhD Thesis, Harvard University.

Steudler, P.A., R.D. Bowden, J.M. Melillo and J.D. Aber. 1989. Influence of nitrogen fertilization on methane uptake in temperate forest soils. *Nature* 341:314-316.

Tomlin, DC. 1990. *Geographic information systems and cartographic modeling.* Prentice-Hall, NJ.

Wiens, J.A., and B.T. Milne. 1989. Scaling of "landscapes" in landscape ecology, or, landscape ecology from a beetle's perspective. *Landscape Ecology* 3:87-96. Sevilleta LTER Publication No. 3.

Whitney, G.G. 1989. (Editor). *Harvard Forest Bibliography 1907-1989.* Harvard Forest, Petersham MA 01366. ■

Global Change Research Agenda Publications

• The Sustainable Biosphere Initiative: An Ecological Research Agenda for the Nineties

To be published in *Ecology*, the journal of the Ecological Society of America (ESA), April 1991 issue. The draft report was circulated for review, and the revised document will require the approval of the ESA Public Affairs and Executive committees in October. A final product should be available by December 1990. In the meantime, draft copies are still available. Jane Lubchenco, Department of Zoology, Cordley Hall 3029, Oregon State University, Corvallis OR 97331-2914.

• The Global Research Agenda: A South-North Perspective

Published by Canada's International Development Research Centre (IDRC). Provides the unique perspective that scientists in the northern hemisphere should incorporate the southern hemisphere and developing countries as they address global change research/issues. Available in English, French and Spanish in both hard copy and microfiche editions. IDRC 1990, P.O. Box 8500, Ottawa, Ontario, CANADA K1G 3H9.

• 1990's Global Change Action Plan: Utilizing a Network of Ecological Research Sites

The proceedings of the November 1989 LTER Network Global Change Workshop in Denver, Colorado. Proposed research plan, 12 action items, and proposed budget. Published by the Long-Term Ecological Research Network Office, University of Washington, College of Forest Resources AR-10, Seattle WA 98195.

Climate Description Monograph

The LTER climate variability working group has completed the proceedings of a workshop held in the summer of 1988. "Climate Variability and Ecosystem Response," is scheduled for publication this fall as a General Technical Report by the Southeastern Region of the U.S. Forest Service.

The monograph has 12 chapters, including an overview and an introduction, with contributions from 10 LTER sites. The final overview chapter, which raises some interesting questions and potential lines of research for LTER, will be sent out for review as a journal article. Work on the Site Climate Description Monograph, another project of the working group, has been delayed until the variability monograph is completed and published.

Contact David Greenland, Geography, Campus Box 260, University of Colorado, Boulder CO 80309. ■

"NTL," from page 5

Personnel

In keeping with NTL's increasing attention to broader spatial and temporal scales, two forest ecologists have joined its research group; Tom Gower as a principal investigator and Mark D. MacKenzie as an assistant researcher with Geographic Information Systems (GIS) expertise.

John Magnuson intends to take a sabbatical in the fall of 1991, to conduct intersite research on spatial heterogeneity and patchiness of different LTER sites at a hierarchy of spatial scales.

For more information contact John J. Magnuson, Center for Limnology, University of Wisconsin-Madison, 680 N Park Street, Madison WI 53706, or Timothy K. Kratz, Trout Lake Station, 10810 County Highway North, Boulder Junction WI 54512. ■

CALENDAR

1990 - 1991

	SEP 25-30	**LTER Meeting: All Scientists** (in lieu of fall '90 Coordinating Committee meeting). Estes Park YMCA Camp, Estes Park CO. Contact John Vande Castle, 206-543-6249, "jvandecastle@lternet.bitnet" or "jvandecastle@lternet.washington.edu"
	25-26	**Symposium: Restoring the Nation's Marine Environment.** Washington, D.C. Contact Ted Lillestolen, NOAA/NMFS, Silver Spring MD, 301-427-2319.
	OCT 7-13	**1st International Symposium on Environmental Studies on Tropical Rain Forests.** Manaus, Amazonas, Brazil. Contact Organizing Committee, Forest '90, Rio de Janeiro, Brazil. Ph: 55-21-211-5581, FAX: 55-21-252-9269.
	8-10	**41st Arctic Science Conference of the American Association for the Advancement of Science.** Anchorage, Alaska. Contact Ann Howell, Conferences & Institutes, University of Alaska, Anchorage, 907-786-1757 or FAX: 907-786-1563.
	9-11	**11th Central States Forest Soils Workshop: Sustained Productivity of Forest Ecosystems.** Seymour Indiana. Contact Pat Merchant, U.S. Forest Service, Bedford IN, 812-275-5987.
	16-19	**International Symposium on Ecological Indicators.** Miami Beach, Florida. Contact Janet McDonald, Kilkelly Environmental Associates, Raleigh NC, 919-781-3150 or FAX: 919-781-9524.
	22-25	**Biodiversity & Landscapes: Human Challenges for Conservation in the Changing World.** Pennsylvania State University, University Park, Pennsylvania, 814-865-8301 or FAX: 814-865-7050.
	29	**NSF Deadline: Basic Research in Conservation & Restoration Biology.** Special competition: Biological, Behavioral, and Social Sciences. Contact Mark Courtney, 202-357-9728, Biotic Systems & Resources; Fred Stollnitz, 202-357-7949, Behavioral & Neural Sciences; Elvira Doman, 202-357-7975, Cellular Biosciences.
	30	**Technical Committee Meeting: National Atmospheric Deposition Program.** San Antonio, Texas. Contact Bill McFee or Walt Heck, Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, 303-491-1977.
	NOV 5-6	**Southern Appalachian Man and the Biosphere Conference.** Gatlinburg, Tennessee. Cooperative agency sponsors: USFS, EPA, Tennessee Valley Authority, Oak Ridge National Laboratory. Contact Betsy Smith, Norris TN, 615-632-1509.
	19-24	**Global Ecology Workshop: Key Problems of Global Ecology & Requirements to Observations.** Leningrad, USSR. Contact Kirill Y. Kondratiev, Scientific Council of the Committee on Systems Analysis. Ph: 164-50-42; FAX: 311-40-89.
	27-29	**Symposium: New Perspectives for Watershed Management.** Seattle, Washington. Cooperative sponsors: University of Washington Center for Streamside Studies, Oregon State University, USFS and EPA. Contact UW Continuing Education, 206-543-0867, or FAX: 206-685-0790.
1991		
	JAN	**LTER Meeting: Executive Committee.** Washington, D.C. (tentative; date to be announced)
SPRING		**LTER Meeting: Coordinating Committee.** Virginia Coast Reserve (VCR) LTER site. (date to be announced)
	MAR 10-13	**8th Annual Pacific Climate (PACLIM) Workshop.** Pacific Grove, California. Contact Julio L. Betancourt, USGS, Tucson AZ, 602-670-6821.
	APR 29-MAY 2	**8th Thematic Conference: Geologic Remote Sensing.** Denver, Colorado. Environmental Research Institute of Michigan, Ann Arbor, 313-9949-1200, ext. 3234, or FAX: 313-994-5123.

University of Washington
College of Forest Resources
Anderson Hall, AR-10
Seattle, WA 98195

Nonprofit Organization
U.S. POSTAGE
PAID
Seattle, WA
Permit No. 62