Annual Report for Period: 08/2001 - 08/2002
Submitted on: 09/25/2002
Principal Investigator: Hayden, Bruce P.
Award ID: 0080381
Organization: University of Virginia
Title:
LTER IV: Long-Term Ecological Research on Disturbance, Succession, and Ecosystem State Change at the Virginia Coast Reserve

Project Participants

Senior Personnel

Name: Hayden, Bruce
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Porter, John
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: McGlathery, Karen
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Zieman, Joseph
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Blum, Linda
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Shugart, Herman
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Anderson, Iris
Worked for more than 160 Hours: Yes
Contribution to Project:
Subcontract through VIMS

Name: Moncrief, Nancy
Worked for more than 160 Hours: Yes
Contribution to Project:
support from Virginia Museum of Natural History

Name: Mills, Aaron
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Brinson, Mark
Worked for more than 160 Hours: Yes
Contribution to Project:
Subcontract through East Carolina University

Name: Christian, Robert
Worked for more than 160 Hours: Yes
Contribution to Project:
Subcontract through East Carolina University

Name: Erwin, R
Worked for more than 160 Hours: Yes
Contribution to Project:
Salary support by USGS/BRD as part of field station at UVA. USGS/BRD employee

Name: Day, Frank
Worked for more than 160 Hours: Yes
Contribution to Project:
Subcontract to Old Dominion University

Name: Galloway, James
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Macko, Stephen
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Young, Donald
Worked for more than 160 Hours: Yes
Contribution to Project:
Subcontract to Virginia Commonwealth University

Name: Oertel, George
Worked for more than 160 Hours: Yes
Contribution to Project:
Subcontract to Old Dominion University

Name: Wiberg, Patricia
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Smith, David
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Albertson, John
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Fuentes, Jose
Worked for more than 160 Hours: Yes
Contribution to Project:

Post-doc

Graduate Student

Name: Tyler, Anna
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Richardson, David
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Knoff, Amanda
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Wu, Jennifer
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: May, Mindi
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Morrison, Sandra
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Lawson, Sarah
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: White, Jessica
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Zinnert, Julie
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Rounds, Rachel
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Parker, Frank
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Dame, Bo
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Keusenkothen, Mark
Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Barr, Jordan
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Rosinski, Jennifer
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Russell, Kristina
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Chauhan, Meetan
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Herod, Devon
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Turaski, Steven
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Dusterhoff, Scott
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Lunsford, Tami
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Holinka, Allison
Worked for more than 160 Hours: No
Contribution to Project:
Worked on mudflat project

Name: Lowit, Michael
Worked for more than 160 Hours: Yes
Contribution to Project:
Supervised by PI Blum

Name: Thomas, Cassondra
Worked for more than 160 Hours: Yes
Contribution to Project:
Supervised by PI Blum

Name: Willis, Patricia
Worked for more than 160 Hours: Yes
Contribution to Project:

Supervised by PI Blum

Name: Dame, James
Worked for more than 160 Hours: Yes
Contribution to Project:
Supervised by PI Christian

Name: McMillan, Brett
Worked for more than 160 Hours: Yes
Contribution to Project:
Supervised by PI Day

Name: Barnes, Diane
Worked for more than 160 Hours: Yes
Contribution to Project:
Supervised by PI McGlathery

Name: Thomsen, Mads
Worked for more than 160 Hours: Yes
Contribution to Project:
Supervised by PI McGlathery

Name: Battistelli, Joseph
Worked for more than 160 Hours: Yes
Contribution to Project:
Supervised by PI Mills

Name: Franklin, Rima
Worked for more than 160 Hours: Yes
Contribution to Project:
Supervised by PI Mills

Name: Galavotti, Holly
Worked for more than 160 Hours: Yes
Contribution to Project:
Supervised by PI Mills

Name: Vandever, Jeffrey
Worked for more than 160 Hours: Yes
Contribution to Project:
Supervised by PI Oertel

Name: McGoff, Nicola
Worked for more than 160 Hours: Yes
Contribution to Project:
Supervised by PI Zieman

Name: Michaels, Rachel
Worked for more than 160 Hours: Yes
Contribution to Project:
Supervised by PI Zieman

Name: Mozdzer, Thomas
Worked for more than 160 Hours: Yes
Contribution to Project:
Supervised by PI Zieman

Undergraduate Student

Name: Skane, Elizabeth
Worked for more than 160 Hours: No
Contribution to Project:

Name: Burton, Jessica
Worked for more than 160 Hours: No
Contribution to Project:

Technician, Programmer

Name: Carlson, Charles
Worked for more than 160 Hours: Yes
Contribution to Project:
Site Manager

Name: Spitler, James
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Smith, Phillip
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Overman, Kathleen
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Restein, Jason
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Patrick, Brannon
Worked for more than 160 Hours: No
Contribution to Project:
Supported by the Virginia Museum of Natural History for work on the fauna of the islands and mainland

Name: Reynolds, Rene
Worked for more than 160 Hours: Yes
Contribution to Project:

Other Participant

Research Experience for Undergraduates

Name: Veloza, Adriana
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site

Home Institution if Other: Stroudsburg University
Home Institution Highest Degree Granted(in fields supported by NSF): Master's Degree
Fiscal year(s) REU Participant supported: 2000
REU Funding: REU supplement

Name: Diaz, Samuel
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: University of Puerto Rico
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2000
REU Funding: REU supplement

Name: Robinson, Jaime
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Same as Research Site
Home Institution if Other:
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2002
REU Funding: REU supplement

Name: Quigley, Katherine
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Same as Research Site
Home Institution if Other:
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2002
REU Funding: REU supplement

Name: Woodworth, Laurel
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Same as Research Site
Home Institution if Other:
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2002
REU Funding: REU supplement

Organizational Partners

NASA, Kennedy Space Flight Center
Collaborative comparative studies between the Virginia Coast and the Merritt Island National Wildlife Refuge

USFWS- US Fish and Wildlife Service

Collaborative, comparative project between the Virginia Coast and the Merritt Island National Wildlife Refuge in Florida

USGS Biological Resources Division

USGS scientist R. Michael Erwin holds a joint faculty appointment at the University of Virginia and collaborates extensively on faunal studies on the Virginia Coast.

PI's Blum and Mills have worked on a collaborative, comparative project between the Virginia Coast and the Merritt Island National Wildlife Refuge in Florida that includes USGS as a partner.

Florida St John's Water Management Dist.

PI's Blum and Mills have worked on a collaborative, comparative project between the Virginia Coast and the Merritt Island National Wildlife Refuge in Florida that includes the St. John's Water Management District as a Partner.

University of Buenos Aires

PI Mark Brinson has been working with Dr. Patricia Kandus, University of Buenos Aires, who visited the VCR site. She is part of a wetland ecology group in UBA biology department working on remote sensing of the Parana River Delta in Argentina. The are involved in developing a management plant for a MAB site in the delta, and are interested in ILTER.

Environmental Protection Agency

The Atlantic Slope Consortium, a group funded by an EPA STAR grant, will be working in the connection between watersheds and coastal estuaries. Primary contacts are through Mark Brinson at East Carolina University (ECU is a member of the consortium and will be conducting evaluations of watershed-estuarine coupling and condtions.) The consortium is coordinated by Penn State (Rob Brooks, PI) and includes other institutions such as Virginia Institute of Marine Science, Smithsonian Environemtal Research Center, and the Environmental Law Institute.

USDA

PI Iris Anderson is working under a USDA -National Research Initiative, Competitive Grants Program with a grant to study physical vs. biological process rates in VCR coastal lagoons

Czechoslovak Academy Science

PI Iris Anderson has been working with the Hydrobiological Institute - Academy of Sciences, Czech Republic on a collaborative study in the Shumava International LTER site.

NASA/Goddard Space Flight Center/Wallops Flight Facility

The VCR/LTER has been designated as a MODIS Validation Site, so NASA has been making available MODIS and other remote sensing data for the site. An Aeronet Sun Photometer has been hosted at the VCR/LTER. It uses changes in solar radiation to quantify atmospheric aerosols.

Participation as a EOS Land Validation core site has provided the VCR/LTER with numerous satellite images (ETM+, IKONOS).

Department of Navy Naval Research Laboratory

PI John Porter has been collaborating with NRL researchers Charles Bachman and Tim Donoto on remote sensing of land cover on the Virginia barrier islands.

Nature Conservancy

Many of our research sites are owned by the Virginia Coast Reserve of The Nature Conservancy. We have also collaborated with them on a variety of projects ranging from landscape ecology of colonial waterbirds, to predator populations, to restoration of dredge spoil sites.

US Army Corps of Engineers

Army Corps of Engineers - They have expertise in sensing leaf optical properties which allows us to identify the presence and degree of stress in plants and, hopefully, the cause of the stress.

Virginia Dept. of Environmental Quality

They continue to provide support for vegetation monitoring on the Swash Bay dredge spoils. The longterm goal of the project is to eradicate or control Phragmites australis at the sites and return the
landscape to native flora and fauna.

Northampton Co. VA Public Schools

Through the Schoolyard Long-term Ecological Research supplement we have been interacting intensively with the Northampton County VA public schools. Students have been used to collect water quality and biological data at a number of sites.

Global Terrestrial Observing System

The VCR/LTER is one of the Terrestrial Ecosystem Monitoring Sites participating in GTOS.

City of Greenville, NC

VCR/LTER PI Robert Christian serves as chair of the Environmental Advisory Commission and is a member of the Comprehensive Planning Committee

Global Ocean Observing System

PI Robert Christian works with both GOOS and GTOS on remotely-sensed monitoring of ocean and terrestrial systems, including the Virginia Coast.

Italian International LTER

PI Robert Christian collaborates with a large number of researchers at coastal sites of the Italian Long-Term Ecological Research Network.

American Type Culture Collection

PI Linda Blum has been collaborating with Dave Emerson of ATCC on studies of the microbial communities on the Virginia coast.

Old Colorado City Communications

They have provided wireless networking equipment and expertise to the VCR/LTER, allowing us to link our island research sites with the Internet at high (2 MBS) rates of speed.

Other Collaborators or Contacts

We have collaborated extensively with researchers at other LTER sites. This includes:

-- Contacts with Scientists from several countries in Southern Africa, specifically exchanges with LTER sites in southern Africa. Remote teleconferencing instruction was offered during 2002 with participants from Mozambique, Botswana and South Africa (Macko)

-- collaborations through workshops. PI Christian organized 2 workshops on network analysis through LTER (one at Snow Bird and one at ECU) and have received support for another (jointly with Alan Covich at Colorado State U.). More collaborations resulted from a biocomplexity workshop on network analysis. The list of collaborators contacts is extensive. They include individuals from other LTER sites, social scientists, and ecologists from outside the LTER network from the USA and abroad. (Christian)

-- Another collaborative effort from a cross-site LTER workshop focused on preseration of soil organic matter in wetlands. This alos involved scientists from the LTER netaork and outside. (Christian)

-- Drs. Jiri Kopacek, Vera Straskrabova, and Jarda Vrba, Hydrobiological Institute, Czech Academy of Sciences --collaborative study of nitrogen cycling processes in mountain lakes of the Sumava ILTER (Anderson, Macko)

-- Dr. Hana Santruckova, University of South Bohemia - collaborative study of N-cycling processes in watersheds of the Sumava ILTER (Anderson)

-- Dr. Rudolph Jaffee, Florida International University, Collaborative study of DOM quality in the VCR coastal lagoons and in PIE estuaries (Anderson)

-- Dr. Charles Hopkinson, Marine Biological Laboratory, PIE LTER, intercomparison of dissolved organic nitrogen dynamics in PIE

(Anderson)

-- University of Georgia and Georgia Tech, GCE-LTER, intercomparison of groundwater/saltmarsh interactions (Anderson)

-- FCE-LTER, Collaborative study of dissolved organic
matter quality (Anderson)

-- James T. Morris (PIE LTER) co-hosted Organic matter workshop held at Virginia Institute of Marine Science, July 26, 01 (Anderson)

-- Dr. Patricia Kandus, University of Buenos Aires, visited the VCR site. She is part of a wetland ecology group in UBA biology department working on remote sensing of the Parana River Delta in Argentina. The are involved in developing a management plant for a MAB site in the delta, and are interested in ILTER. (Brinson)

-- PI Blum has been an active participant in cross LTER Organic Matter Workshops organized by Jim Morris. The goal of these workshops has been to compare organic matter accumulation in wetland sediments and the mechanisms controlling OM accumulation and to plan a series of experiments that include controlled laboratory incubations and reciprocal transplants of soil cores. Measurements might include CO2 and CH4 flux, O2 consumption, DOC loss, root ingrowth of cores, molecular characterization of microbial communities, pyrolosis GCMS and nutrient characterization of organic matter composition (new
production and old SOM). (Blum)

-- Blum is PI on NSF funded cross-site comparison study to examine the relative importance of local abiotic conditions vs. organic matter on microbial communities associated with decaying marsh grass and mangrove litter. Collaborators include: Gary King, Univ. of Maine Chuck Hopkinson, PIE LTER John Hobbie, PIE LTER Randy Chambers,
College of William and Mary Mike Reiter, Delaware State Univ. Bob Christian, East Carolina Univ. Jim Morris, Univ. South Carolina, NIN Steve Newell, GCE LTER Jay Garland, Dynamac Corp, NASA Mike Roberts, Dynamac Corp, NASA Joy Boyer, FCE LTER

-- Collaborative project with NASA Kennedy, USFWS, USGS,and State of Florida's St. John's Water Management District - working on comparison of the contribution of primary production and decomposition to organic matter accumulation and the effect on salt marsh sediment surface elevation changes between VCR and Merritt Island National Wildlife Refuge. Collaborators include: Ross Hinkle, Dynamac, Corp. Kelly Gorman, NASA Ron Brockmeyer, St. John's Water Management District Don Cahoon, USGS Mark Epstein, USFWS (Blum, Mills)

-- We have also had active contacts with African researchers interested in establishing International LTER sites. With an NSF supplement we hosted a workshop 'SOUTHERN AFRICA VIRGINIA NETWORKS AND ASSOCIATIONS - SAVANA I' Nov. 6-10, 2000. The purpose of the workshop was to explore scientific research topics, to share information about broad institutional collaboration, and to identify demonstration projects that would lay the foundations for a regional environmental research and teaching infrastructure. The workshop participants identified three demonstration projects: (1) a collaborative distance learning project initially including WITS, the University of Eduardo Mondlane, and UVA; (2) an ecology and sustainable resource management station on the Mozambique coast; and (3) a collaborative ecological research station in the eastern Lowveld/Limpopo River basin that joins three existing stations in South Africa and Mozambique. Co-Convenors of the workshop were Harold Annegarn, Atmosphere and Energy Research Group, University of Witswatersrand, South Africa; Robert Swap, PI, SAFARI 2000 (Southern Africa Regional Science Inititative), Department of Environmental Sciences, University of Virginia; Hank Shugart, Leader, Global Climate Change Program, Department of Environmental Sciences, University of Virginia and participanting scientists were Pauline Opha Dube, Department of Environmental Sciences, University of Botswana; Bane Marjanovic, Director, Sasol Centre for Innovative Environmental Engineering, Department of Civil Engineering, University of Witswatersrand; Peter Omara-Ojungu, Dean, School of Science, University of Venda; Lars Ramberg, Director, Harry Oppenheimer Okavango Research Center, University of Botswana, Maun; Francisco Vieira, Dean, School of Science, Universidade Eduardo Mondlane, Mozambique; 'Diran Makinde, Dean, School of Agriculture, Rural Development, and Forestry, University of Venda; Stephen Macko, Workshop Program Chair, Department of Environmental Sciences, UVA; Paul Desanker, Coordinator, Miombo Network, UVA; and Mike Garstang, Bruce Hayden (Director, Virginia Coastal Reserve NSF LTER), Christelle Hely, Don Clark, Lufafa Abel, and Sam Alleaume, all faculty members in the Department of Environmental Sciences, UVA, and 13 graduate students.

-- In May 2001, African scientists Susan Ringrose, Luisa Santos, Rui Brito, and Almeida Sitoe visited the VCR/LTER. They toured the research site and met with VCR/LTER PI's and information specialists to discuss issues surrounding the creation and operation of LTER sites.

-- In July 2002, VCR/LTER PI's Zieman, Macko, Porter and Shugart participated in a series of meetings in Mozambique, South Africa and Botswana. These included participation in the Ecological Long-term Observatories of Southern Africa (ELTOSA) meeting (an International LTER regional group), Information Management training in Maputo, Mozambique, presentations on ecological information management to the

staff of Kruger National Park in South Africa and a series of meetings with university administrators at a variety of South African universities.

Non-LTER collaborations include:

-- Boise State University - Dr. Steve Novak along with Dr. Greg Plunkett (VCU) and me are collaborating on an integrated project (genetics, populaton biology, and physiological ecology) to assess the invasion potential of Phragmites australis on the Eastern Shore of Virgina. (Young)

-- Dr. Randy Chambers, Director Keck Laboratory, College of William and Mary - study of nutrient cycling processes in mudflats of the VCR (Anderson)

Dr. Carl Friedrich, Virginia Institute of Marine Sciences. Collaboration with Anderson on modeling studies of particle transport and residence times in Hog Island Bay (Anderson)

-- Dr. Mandy Joye, University of Georgia and Dr. Carolyn Ruppel, Georgia Tech, Groundwater flow at the salt marsh interface (Anderson)

-- Matt Jones, National Center for Ecological Analysis and Synthesis. Collaboration on testing of Ecological Metadata Language. (Porter)

-- Dr. Raymond Dueser, Utah State University, Barry Truitt, The Nature Conservancy. Mammalian predators often have severe negative effects on colonial-nesting waterbirds such as gulls, terns and shorebirds. These effects may vary with predator and prey species and with habitat, but often are extreme for introduced predators on islands. The raccoon (Procyon lotor) and red fox (Vulpes vulpes) are frequently implicated on islands. Based on both long-term anecdotal accounts and 20 years of breeding bird counts, most beach- and dune-nesting colonial waterbird populations have declined in recent decades on the Virginia barrier islands. It has been proposed that much of this decline is attributable to expanding distributions and increasing abundances of raccoons and red foxes. Direct effects such as nest depredation have been observed repeatedly but relatively infrequently over the past 20 years. We have been working to determine more directly the effects of mammalian predators on nesting waterbirds. There appeared to be a real effect of mammalian predators on nesting colonial waterbirds (in the form of reduced bird abundance) even in the absence of apparent effects (in the form of signs of depredation) in a given year. These results support the contention that mammalian predators have had a significant long-term effect on colonial-nesting waterbirds on the Virginia barrier islands despite the infrequency of observed direct effects. This study represents a highly effective partnership among The Nature Conservancy, the Virginia Museum of Natural History, the Virginia Department of Environmental Quality and the VCR-LTER Program.(Moncrief, Porter)

We collaborated in 2002 with Dr. Ronald A. VanDenBussche, Department of Zoology, Oklahoma State University, in an (mtDNA)analysis of the phylogeography of raccoons on the Virginia barrier islands and the adjacent the Delmarva Peninsula (Moncrief).

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)

See attached file

Findings: (See PDF version submitted by PI at the end of the report)

See attached file

Training and Development:

We have engaged in training at all levels of education. At the graduate level we have a large number of students who participate in the research conducted at the VCR/LTER. A smaller number of undergraduate student REUs participate in research, while a larger number of undergraduates experience the LTER site through class field trips. In the K-12 area we are engaged in taking hands on science into the classroom in the area of field measurements using state-of-the-art equipment. This involves classroom teaching on the part of VCR scientists, field demonstartions and WEB based communications.

Some specific training and development activities were:
Robert Christian led a cross-site workshop to help develop the experise of network analysis within the LTER network. He is teaching a course at ECU in 'global issues in coastal ecology' which promotes large-scale thinking and is tied to the first panel meeting for the coastal module of

GTOS. He directed 2 graduate students, and with their help, four undergraduates on projects at the VCR. Also, a high school student has worked with him.

Nancy Moncrief employed two undergraduate research assistants during 2001. Sandra Keil was a rising senior in environmental Studies at Utah State University, with particular interests in natural resources management and policy. She graduated from USU in May 2002, and is currently employed as a natural resources policy specialist in the Washington office of Congressman Jim Gibbons of Nevada. Curtis Smith was a rising junior at James Madison University and an Eastern Shore native from Wachapreague.

Outreach Activities:

The Schoolyard LTER program continues to be a meaningful way of increasing future public understanding.

During the past year we have worked with The Nature Conservancy on issues of landscape dynamics, surveys of bird populations and on the extend of envasive species.

Robert Christian has been active with the Italian International LTER program, which looks like it may be getting off the ground.

Nancy Moncrief used distributional data collected from the multi-island surveys in a Teacher Re-Certification class that she teaches through the University of Virginia at the Roanoke Higher Education Center. She reviewed processes such as extinction and colonization and concepts such as succession, habitat complexity, and carrying capacity. Typically, there are 20-30 K-12 teachers in this course each year. Her work at VCR/LTER was featured in an article about me that appeared in VMNH's popular publication The Virginia Explorer, published in May 2002.

Don Young was appointed to the Governor's Advisory Board of Soil Scientists and Wetlands Professionals. We will be developing guidelines for certifying professionals as wetlands ecologists.

Bruce Hayden serves on the Florida Coastal Everglades Advisory Committee

John Porter is the outgoing chair of the User Working Group of the NASA Global Change Master Directory. He participated in ILTER workshop and training activities in southern africa in July 2002.

Images from the VCR/LTER WWW site have appeared in a number of publications for the general public. These include Chesapeake Life Magazine, UVA Insights and the Eastern Shore Post.

The VCR/LTER WWW site (http://www.VCRLTER.virginia.edu)is widely used. 31.752 gigabytes were downloaded from the site during the period 8/01/01 through 7/31/02. This included over 1 million requests for web pages from 106,027 unique computers. Educational users accounted for 26% of all requests with commercial users (or educational users using a commercial network provider) accounted for 25%. A complete web statistics report is available at: http://www.vcrlter.virginia.edu/analog/2001/ .

Journal Publications

McGlathery, K. J., "Macroalgal blooms contribute to the decline of seagrass in nutrient-enriched coastal waters", Journal of Phycology, p. 1, vol. 35, (2001). Published

Anderson, I. C., K. J. McGlathery, and A. C. Tyler, "Microbial processing of reactive nitrogen in a temperate coastal lagoon", Marine Ecology Progress Series, p. , vol. , ( ). Submitted

Baker, K.B. B.J. Benson, D.L. Henshaw, D. Blodgett, J.H. Porter, and S.G. Stafford, "Evolution of a Multisite Network Information System: The LTER Information Management Paradigm", BioScience, p. 963, vol. 50, (2000). Published

Barimo, J.F. and D.R. Young, "Grasshopper(Orthoptera:Acrididae)-plant-environmental interactions in relation to zonation on an Atlantic Coast
barrier island", Environmental Entomologist, p. , vol. , ( ). Submitted

Barimo, J.F. and D.R. Young, "Insect-plant-environmental interactions in relation to primary succession in a coastal ecosystem", Oikos, p. , vol. , ( ). Submitted

Berg, P. and K. J. McGlathery, "A high-resolution pore water sampler for sandy sediments", Limnology and Oceanography, p. 203, vol. 46, (2001). Published

Blum, L.K. and Christian, R.R., "Below
ground production and decomposition along a tidal gradient in a Virginia, U.S.A, salt marsh", Estuaries, p. , vol. , ( ). Submitted

Brinson, M. M., and R. R. Christian, "Assessing functions of wetlands and the need for reference", Biologia Ambientale, p. , vol. , ( ). Accepted

Brinson, M.M., "Fluvial forms and processes: A new perspective (book review)", Ecological Engineering, p. 307, vol. 14, (2000). Published

Christiansen, T., P.L. Wiberg and T.G. Milligan, "Flow and sediment transport on a salt marsh surface", Estuarine, Coastal and Shelf Science, p. , vol. , ( ). Accepted

Craig, C.L. and D.R. Young, "Physiological responses of Phragmites australis to flooding at variable salinities", Wetlands, p. , vol. , ( ). Submitted

Crawford, E.R. and D.R. Young, "Comparison of gaps and intact shrub thickets on an Atlantic Coast barrier island", American Midland Naturalist, p. , vol. , ( ). Accepted

Day, F.P., C. Conn, E. Crawford, and M. Stevenson, "Long-term effects of nitrogen fertilization on plant community structure on a coastal barrier island dune chronosequence", Canadian Journal of Botany, p. , vol. , ( ). Submitted

Day, F.P., E. Crawford, and J.J. Dilustro, "Plant biomass change along a coastal barrier island dune chronosequence over a six-year period", J. Torrey Bot. Soc., p. 197, vol. 128, (2001). Published

Elliott, M.T. and D.R. Young, "Influence of tidal wrack and microtopography on strand species and on community composition", American Midland Naturalist, p. , vol. , ( ). Accepted

Erwin, R.M. and B.R. Truitt, "Nowhere to hide:
ground-nesting waterbirds and mammalian carnivores in the Virginia barrier island region", Journal of Coastal Research, p. 292, vol. 17, (2001). Published

Franklin, R.B., D.R. Taylor, and A.L. Mills, "The influence of chemical environment and spatial separation on the distribution of microbial communities in anaerobic and aerobic zones of a shallow coastal plain aquifer", Microb. Ecol., p. , vol. , ( ). Submitted

Giannotti, A. L. and K. J. McGlathery, "Consumption of Ulva lactuca (Chlorophyta) by the omnivorous mud snail Ilyanassa obsoleta", Journal of Phycology, p. 1, vol. 37, (2001). Published

Havens, K. E., A. C. Tyler, J. Hauxwell, S. Thomas,
K. J. McGlathery , I. Valiela, J. Cebrian, A. D. Steinman, and S. J. Hwang, "Complex interactions between primary producers in shallow marine and freshwater ecosystems: Implications for community responses to nutrient stress.", Environmental Pollution, p. 113, vol. , (2001). Published

Howarth, R., D. Anderson, J. Cloern, C. Elfring, C.
Hopkinson, B. Lapointe, T. Malone, N. Marcus, K. McGlathery, A. Sharpley, and D. Walker., "Nutrient Pollution of Coastal Rivers, Bays and Seas", Ecological Issues, p. 1, vol. 7, (2000). Published

Hutton, J. and F.P. Day, "The effect of
nitrogen fertilization on short-term fine root dynamics in a barrier island dune community", Plant and Soil, p. , vol. , ( ). Submitted

Joy, D.A. and D.R. Young, "Promotion of mid-successional seedling recruitment and establishment by Juniperus virginia in a coastal environment", Plant Ecology, p. , vol. , ( ). Accepted

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Web/Internet Site

URL(s):

http://www.VCRLTER.virginia.edu

Description:

This WWW site serves as the "file cabinet" for the VCR/LTER Project - both for researchers within the project and external scientists. It provides access to a wide array of information products derived from the grant including data, searchable bibliographies, full text of proposals and theses and dissertations. The site is heavily used, with over 31.7 GB of data downloaded to over 106,000 different computers during the period September 2001 through August 2002.

Other Specific Products

Product Type: Data or databases

Product Description:

The VCR/LTER provides access to more than 75 formally documented data sets. They are listed on the WWW at: http://www.vcrlter.virginia.edu/data.html. They include physical, biological, geographical and model data sets. Some data sets also support sophisticated queries, such as our biodiverisity database, or extensive graphical output, such as our meterlogical and tide data sets. In addition to the formal data sets we provide a wealth of textual and graphical material resulting from research at the VCR/LTER.

Sharing Information:

Data is made available via the WWW in conformance with LTER-wide data policies. As noted in the 'contributions' section, the data is widely used for research and education, with over half (58%) of the data requests coming from researchers, educators and students not associated with the VCR/LTER.

Product Type: Physical collection (samples, etc.)

Product Description:

In collaboration with the Virginia Museum of Natural History, we have established a sample archive for the VCR/LTER. This includes mammalian tissue samples, as well as soil, and water. To date, collections at the Virginia Museum of Natural History include more than one thousand traditional skin and skeletal preparations of 18 species of mammals from more than 40 locations on the Virginia barrier islands and southern Delmarva Peninsula. Ninety-nine percent of these specimens are accompanied by frozen tissue samples (heart, liver, kidney, and skeletal muscle). Also, intensive long-term live-trapping data were collected for 3 island sites and 3 sites on the adjacent mainland for a five-year period. In conjunction with that study, non-invasive tissue samples (earclips) were collected from more than two thousand individuals of three species of rodent.

Sharing Information:

These samples are available through standard loan procedures of the Virginia Museum of Natural History.

Product Type: Audio or video products

Product Description:

We provide online access to over 20,000 images of ecological research activities and sites at http://www.VCRLTER.virginia.edu/images. This includes several compressed videos of our site and research procedures on the WWW at http://www.vcrlter.virgina.edu/video. These are not 'production quality' videos, but aid in the orientation researchers who may be interested in conducting research at the VCR/LTER.

Sharing Information:

Images are available in standard Internet formats (.jpg and .gif) at http://www.VCRLTER.virginia.edu/images/
They are available in RealPlayer or Windows Media Player formats on the WWW site: http://www.vcrlter.virgina.edu/video

Product Type: Teaching aids

Product Description:

We provide live Webcams viewing research sites of the Virginia Coast Reserve LTER. These are used by K-12 students to view these remote islands.

Sharing Information:

Cameras and time series of images can be viewed at: http://www.VCRLTER.virginia.edu/wwwcam/

Contributions

Contributions within Discipline:

LAGOON

Coastal eutrophication has been recognized as an increasing problem in areas such as the East and Gulf coasts of the U.S. Symptoms of eutrophication include blooms of phytoplankton, which when they decompose may reduce available oxygen in the water; blooms of harmful algae that are toxic to fish, shellfish, and occasionally humans; blooms of macroalgae that cause die-backs of sea grasses which are vital to maintaining populations of many fish and crabs. Eutrophication generally results from export of excess nutrients from land, in particular nitrogen. Sources of nitrogen include agriculture, septic tanks, waste water treatment plants, industry, and atmospheric deposition of nitrogen derived from automobiles, power plants, and other industrial sources. Nitrogen from these sources is most often transported to coastal waters in shallow groundwater and in surface water runoff.

Coastal lagoons are common features of the land margin, especially along the East and Gulf coasts. We have hypothesized that these lagoons play an important role in retarding and transforming nitrogen during transport from land to the sea. Our study of the Virginia Coast Reserve lagoonal system has been designed to: (1) measure groundwater sources of nutrients to the lagoon; (2) measure rates of biological processes that remove or transform nitrogen in the waters and sediments of the lagoon; (3) compare rates of nitrogen cycling processes to physical transport across and out of the lagoon in order to determine whether the nitrogen remains in the lagoon for a sufficient length of time to allow biological processing to occur. The biological studies described in this report are being performed jointly by Iris Anderson, VIMS, and Karen McGlathery, University of Virginia.

Our preliminary results support our hypotheses that: (1) nitrogen entering the lagoon is rapidly removed by both benthic macro- and microalgae. The bloom of macroalgae that results in early summer crashes during mid-summer, releasing much of the nitrogen as dissolved inorganic and organic nitrogen. The sediments act to rapidly remove the nitrogen released to the water column by a combination of mechanisms including immobilization by benthic microalgae and coupled nitrification - denitrification. We are currently attempting to determine how the nitrogen released during decomposition of the macroalgal bloom is partitioned between the various potential consumptive mechanisms.

MARSH

Recent work on microbial communities in the marshes and tidal creeks at the VCR (as well as 9 other coastal systems as part of a cross-site comparison study) contribute to our understanding of what abiotic and biotic factors determine microbial community structure and the scales over which microbial communities vary. Linking information about variation in microbial community structure and microbially controlled processes (e.g., nitrogen-fixation), will allow prediction of how critical ecosystem processes will be affected by disturbance. (Blum)

We have begun to organize a small group to compare the ways in which salt marshes, mangroves and coral reefs respond to sea-level change and are perceived to respond to sea-level change. This synthesis promises to be valuable. (Christian)

The work culminating in the masters theses of Scott Dusterhoff (under supervision of Albertson and Wiberg) and Steven Turaski (supervised by PI Wiberg) has applied instrumentation and models most commonly used in studies of fields and forests to marshlands. Measurements of

soil moisture (using TDR), water table elevation, soil texture and topography were used to characterize near surface soil moisture dynamics and runoff potential across a marsh-upland transect at Phillips Creek Marsh, VCR-LTER. Models of soil moisture (Richards equation) and evapotranspiration were successfully used to investigate controls on soil moisture and water table level, including soil texture, elevation, root density in addition to precipitation, tidal inundation and etc.

One of PI Robert Christian's major commitments for the last couple of years has been to encourage and promote the use of network analysis within ecology. Network analysis is a modeling tool (really an accounting tool for data. These data must be organized in a network form of interactions aomong system compartments) These efforts have come to some fruition via publications and workshops sponsored by NSF biocomplexity and the LTER network. Now several groups within and beyond the LTER network have begun using the tools. Jim Morris at U. South Carolina and PI Christian have collaborated on large number (>1,000) compartment networks, randomly generated but following perscribed rules. We have found some distribution dependent and independent attributes of food webs.

UPLAND

The results of this work to date have increased our understanding of dynamic vegetation changes and their causes in coastal barrier island ecosystems.

To date, one of our most significant contributions has been to demonstrate that biotic interactions are very important in the coastal environment of the VCR, which we often define as being dominated by physical parameters. Most importantly PI Donald Young, demonstrated the importance of the presence for a soil actinomycete, Frankia, for the successful establishment of Myrica cerifera. Myrica usually is usually the first woody species to establish in these environments. Once established, Myrica rapidly forms extensive thickets in coastal environments. These thickets are excellent indicators of island stability and may be precursors to the establishment of maritme forest.

Ten years of research in shrub thicket ecology has provided excellent background and experience for studying the potential for invasive species in coastal environments. This is especially true for the weedy grass, Phragmites australis. Populations of Phragmites are establishing and rapidly expanding throughout the VCR as well as in coastal environments of the mid-Atlantic region. Phragmites often establishes in habitats similar to those of shrub thickets.

Studies of island-dwelling organisms, such as those underway at VCR, have long played an important role in testing ecological and evolutionary theory about patterns and processes related to distribution and abundance of species and genetic variation within and among natural populations. The Virginia coast is a highly dynamic, frequently disturbed landscape, and the Virginia barrier islands are the only undeveloped barrier system on the Eastern seaboard. As such, this system affords a unique opportunity to study phenomena associated with island systems, including fragmentation of habitats and populations, local extinction, dispersal, and colonization, which are also important issues in conservation biology.

Contributions to Other Disciplines:

The studies conducted by the VCR/LTER are inherently interdisciplinary or multidisciplinary. Our studies are being performed by an interdisciplinary team of ecologists, hydrologists, biologists, and physical oceanographers. When such collaborations take place, it is not unusual that each each group of scientists will gain greater insight into problems that may not be recognized within their own discipline.

Additionally, our workshops on network analysis have exposed a broad group of scientists to the field or network ecology. Social scientists have also used network analysis, and one of our accomplishements has been to bring awareness of the different approaches to the broader group. (Christian)

Research on ecological information management has included computer scientists. The challenges posed by ecological data provide opportunities for innovation in computer science. (Porter)

Contributions to Human Resource Development:

As can be seen from the number of graduate and undergraduate students listed on our participant list, this project provides abundant opportunities for training. Moreover, the inter- and multi-disciplinary nature of the research teaches the students how to operate in a collaborative environment.

From August 2001 through July 2002, the LTER laboratory has been used by six classes totaling more than 60 undergraduate students. Two intensive classes worked at the site for 5 days straight. One focused on ecological systems and provided the LTER site with data on bird colony locations and structure of marsh communities along a topographic gradient. The other focused on using remotely sensed data to assess the landscape and the design of ground reference data collection schemes.

We have, in our Schoolyard LTER program provided instruction and assistance to local teachers as well as graduate courses in assistance of their recertification. We have brought LTER research activities into the classroom had extensive contact with more than 150 students in grades 9-12. Two teachers participated in the Research Experience for Teachers program where they participated in experiences with a large number of researchers and are developing individual research projects.

PI Nancy Moncrief used distributional data collected from the multi-island surveys in a Teacher Re-Certification class that she teaches through the University of Virginia at the Roanoke Higher Education Center. She reviews processes such as extinction and colonization and concepts such as succession, habitat complexity, and carrying capacity. Typically, there are 20-30 K-12 teachers in this course each year. Additionally, she has developed a K-12-level activity that illustrates various island biogeography principles. She distribute it through Teacher Recertification courses and workshops.

Contributions to Resources for Research and Education:

Our WWW site (http://www.vcrlter.virginia.edu) provides access to a wide variety of information in text, graphical and video forms. Data are frequently downloaded for use by classes and researchers at institutions not associated with the VCR/LTER. Since the beginning of this grant in Nov. 2000, we have provided data for 217 formal requests. 30% were by VCR/LTER associated researchers, but 57% were from individuals not associated with the VCR/LTER. 63% of the total requests were for research use and an additional 33% were for classroom use. 12% of the total requests were from outside the US including India, China, Indonesia, Chile, Australia, Germany and the United Kingdom, among others.

Through our Schoolyard LTER supplement, we have been able to provide equipment such as global positioning system, taxonomic guides and water chemistry analysis kits and equipment to the Northampton Co. VA Public Schools. This program now extends from grades 6-12 through the Northampton Co. middle and high schools.

Work that we are currently doing at the VCR is of much interest to the Department of Environmental Quality of the State of Virginia, and in particular to the Water Conservation Districts located on the Eastern Shore. The major source of nitrogen to VCR coastal lagoons is agriculture. Proper management of agricultural activities and fertilization practices requires an improved understanding of nitrogen losses to the coastal lagoons via groundwater and surface water runoff.

Contributions Beyond Science and Engineering:

We have engaged in studies designed aid the conservation of avian fauna and better understanding of the extent and change in exotic plant species in the coastal zone in conjunction with The Nature Conservancy. (Erwin, Porter, Hayden, Blum, Albertson, Young)

Knowledge of the relationship between land use, nutrient contamination of groundwater, groundwater export of nutrients to coastal lagoons, and the fate of nutrients within lagoons will be of benefit to state and federal agencies charged with managing coastal resources. (Anderson)

Linking information about variation in microbial community structure and microbially controlled processes (e.g., nitrogen-fixation), will allow prediction of how critical ecosystem processes will be affected by disturbances due to human activities in the coastal zone. (Blum)

As described elsewhere, my activities with the UN programs on observing global change along coastal ecosystems have significance for broad aspects of public welfare and environmental protection. (Christian)

Special Requirements

Special reporting requirements: None

Change in Objectives or Scope: None

Unobligated funds: less than 20 percent of current funds

Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Research by Virginia Coast Reserve Long-term Ecological Research project (VCR/LTER) scientists continues to focus on our core hypothesis that ecosystem, landscape and land use patterns within terrestrial-marine watersheds are controlled by the vertical positions of the land, sea and freshwater groundwater table surfaces. Coastal storms, climate change, long-term eustatic sea-level rise and land subsidence cause variations in the elevations of these surfaces that drive ecosystem dynamics. Ecological processes, including organic matter production, species extinction and colonization, alter the rates of erosion and sediment deposition and thereby alter land and water table surface elevations. Short-term episodic events and long-term systematic trends in sea level and land and and groundwater surfaces give rise to variations in nutrient availability, primary productivity, organic matter accumulation and trophic interactions.

Continuing research focuses on collection of long-term data sets and maintenance of long-term experiments started during VCR/LTER III (1994-2000). In 2001, we initiated additional monitoring and experimental work in the uplands, lagoons, marshes of the Virginia Coast Reserve. These activities and our findings are outlined below.

Activities:

Upland:

Our activities in the upland have focused on better understanding the relationship between ground-water and land-surface free surfaces, and how this relationship affects ecological processes including productivity, decomposition. A special effort this year is an attempt to integrate data on meteorology with our records of primary productivity. We have also been engaged in studying the trophic structures related to gulls and colonial waterbirds. With external funding and collaborators (notably Raymond Dueser), we have been examining the relationship between introduced and native predators and productivity of nesting colonial and beach nesting waterbirds and have been using stable isotope analyses to better understand bird feeding patterns. Additionally, we improved our monitoring capabilities by installing a wireless network out to our Hog Island research site. Specific activities include:

1. Initiated intrasite (VCR) synthesis activities were initiated to examine interannual productivity patterns in relation to meteorological and climatological variables. (Christian, Day, Blum, Young, Brinson, Mills, McGlathery, Zieman, Hayden and Porter). This ongoing effort started with developing a database of meteorological and climatological data that combines LTER meteorological station data with external data that predates the initiation of the VCR/LTER site. Data on productivity and indicators of productivity (e.g., biomass, stem counts) were compiled for *Myrica cerifera*, *Spartina patens*, *Spartina alternaflora*, and *Distichlus spicata*. The research group then met in early July to work on analyses of this data, focusing on within-site and within-species relationships between production and climatological variables.

2. Measured the nitrate removal from groundwater by riparian wetlands. (Mills)

3. Investigated the biogeography of microbial decay communities. (Mills, Blum)

4. Continued monitoring of permanent vegetation plots and groundwater wells on Hog Island. A new doctoral student is completing preliminary observations prior to initiating his dissertation work on vegetation dynamics on "pimples". (Day)

5. Used stable isotope analyses to characterize the sources of food for gulls (Macko, Erwin, Knoff).

6. Installed a wireless network link over 25 km between our laboratory in Oyster VA and our field research sites on Hog Island. Our goals for the VCR/LTER wireless project were ambitious and threefold: 1) to allow transmission of meteorological and other digital data sources from our island study sites back to our researchers, 2) to provide access to real-time weather radar an other web-based information sources for researchers and technicians in our study areas and 3) to support video-teleconferencing for use with classes and real-time interactions between researchers, students and technicians located at both island and mainland locations. We were extremely fortunate in several respects. Most importantly, we received huge amounts of help, and even equipment, from Dave Hughes and Tom Williams of the NSF-funded Biological Sciences by Wireless Project (http://wireless.oldcolo.com/).

7. The Virginia barrier islands historically have been among the most important nesting areas for colonial and beach-nesting waterbirds in the entire mid-Atlantic region. The apparent spread of the raccoon (Procyon lotor) and the introduced red fox (Vulpes vulpes) on these islands has significantly reduced habitat suitability for these avian species. Our work in 2001 was the third year of a study designed to produce a strategic plan for restoring avian habitat through predation management. We undertook five tasks in 2001: (1) We removed all raccoons and red foxes from Metompkin (1; 2) and North Cedar (6; 0) Islands during March. We also removed eight raccoons from North Smith Island during March, and trapped extensively on Wreck, Ship Shoal and Myrtle Islands. (2) We monitored the numbers of colonial and beach-nesting waterbirds on these five islands periodically from June through August. (3) We radiocollared and translocated 15 raccoons between islands during Summer 2001, displacing each animal from its home island to a neighboring island separated by a continuously-flooded tidal creek 50–300 m in width. Straight-line translocation distances ranged from 1,417 m to 7,940 m. (4) We began an analysis of the genetic structure of island and mainland raccoon populations, using mitochondrial DNA sequencing to examine the pattern of genetic differentiation among island and mainland raccoon samples. (5) We continued the systematic track surveys that were begun in October 1998. (Moncrief, Dueser, Porter)

8. We are studying the complex relationships between barrier island morphology and disturbance and the distribution and abundance of mammal populations. In addition to conducting traditional trapping surveys to determine presence/absence and estimate abundances, we are developing molecular markers useful in exploring ecological processes such as colonization and extinction and evolutionary processes such as gene flow in the highly fragmented landscape of the VCR. (Moncrief, Dueser, Porter)

9. One set of ongoing genetic analyses involves three species of rodents are characterized by demonstrably different over-water dispersal abilities. We have already assessed genetic variation in two of these rodents (*Oryzomys palustris* and *Peromyscus leucopus*). Previous efforts to collect the third species (*Microtus pennsylvanicus*) failed to provide adequate sample sizes. So far this year we collected animals from one of the island sites, and we plan to collect additional animals from several other localities in the fall. (Moncrief, Dueser, Porter)

10. Declassified satellite imagery was used to examine landscape change since 1963 on Hog Island and Phillips Creek research sites (Porter, Hayden). This imagery was obtained with the help of John Vande Castle at the LTER Network Office and Scott Collins at the National Science Foundation.

11. In the area of cross site studies, we have done work at the Florida Coastal Everglades and Sevilleta LTER sites aimed at understanding the relationship between vegetation hydrocarbon emissions and climate controls (Hayden)

Lagoon:

The lagoons within the VCR constitute the ecological bridge between our mainland and island research sites. Activities of primary producers and heterotrophs influence the degree to which lagoons retain or remove watershed nutrients and organic matter during transport from the mainland to the coastal ocean. Specific research activities in the lagoon include:

1. Continued intensive monitoring program for Hog Island Bay and its tributaries (McGlathery, Anderson, Blum, Christian)

2. Continued study of the role of land use in affecting groundwater quality (base flow) in 14 tributaries to coastal lagoons in the VCR (Anderson, McGlathery)

3. Continued study of nitrogen transformations (nitrogen fixation, mineralization, nitrification, denitrification in the water column and sediments of Hog Island Bay (Anderson, McGlathery)

4. Continued measurements using a digital fathometer integrated with global positioning system measurements to extend our bathymetric mapping to include lagoon inland of Smith Island (Oertel, Carlson)

5. Continued studies of lagoonal surface circulation using sequential global positioning system locations of "drifters" (Oertel, Carlson)

6. Continued development of model to determine variable residence times in and water transport in shallow subtidal areas of Hog Island Bay (McGlathery, Anderson with collaborator Friedrichs)

7. Wet- and dry-deposition fluxes of N were quantified and were used to assess their contribution to the nutrition of primary producers in Hog Island Bay. In shallow coastal lagoons where fluxes from fluvial sources are small, the role of atmospheric nitrogen may be significant. From 1990 through the present, wet-only precipitation was sampled weekly with an automatic, solar-powered device and analyzed for NO_3^- and NH_4^+concentrations. Between February 1990 and November 1995 the collector was deployed on Hog Island. Thereafter, it was moved to the nearby (15 km S) Eastern Shore of Virginia National Wildlife Preserve. (Galloway)

8. Atmospheric concentrations of the of major nitrogen-containing species, including gaseous NH_3 and HNO_3, particulate NH_4+, NO_3^-, NO_2^-, total water-soluble organic nitrogen (ON_{ws}) and total non-water-soluble organic nitrogen (ON_{nws}), were measured and modeled, and the corresponding dry-deposition fluxes were determined. (Galloway)

9. Continued analysis of the distribution, abundance and performance of macroalgae in Hog Island Bay in relation to the ambient water motion regime. Hog Island Bay is dominated by free-floating and attached macroalgae, but was previously dominated by sediment-binding rooted eelgrass. Recent observations indicate that eelgrass is

slowly returning to Hog Island Bay, potentially reversing to the clear water ecosystem state within the next 2-3 decades. (McGlathery)

10. Evaluated the trophic interactions between macroalgae and benthic fauna. Determined seasonal changes in the macrofauna present within the algal mats and within the sediment immediately under the algal mats and the effects of macroalgal density on the macrofauna were. The grazing impact by amphipods and snails on macroalgal abundance is also being evaluated to assess the role of grazers in mediating N transformations in the lagoon. (McGlathery)

11. Determined the effect of ultraviolet radiation on the production of inorganic nitrogen, urea and amino acids from aquatic dissolved organic matter in Hog Island Bay. Waters representing distinct sources of dissolved organic matter to the lagoon were subjected to UV light mimicking the natural solar spectrum. (McGlathery)

12. Quantified benthic-pelagic fluxes of specific dissolved organic and inorganic N compounds along an environmental gradient in Hog Island Bay, and determined how uptake and release by benthic algae impacts nitrogen dynamics. Estimated the turnover rate of the macroalgal N pool to determine the impact of benthic algae on the processing of nitrogen inputs to the lagoon. (McGlathery)

13. Initiated research on the use of macroalgae as bioindicators of nutrient enrichment from agricultural watersheds to Hog Island Bay. (McGlathery, Zieman)

14. Continued measurements of sediment resuspension and light attenuation in Hog Island Bay. An aim of the research is to identify potential areas of seagrass return in Hog Island Bay. (Wiberg, McGlathery)

Marsh:

Marshes represent the biomes most susceptible to alteration due to changes in sea level. For this reason we have focused on understanding the relationship of marsh surfaces to sea level rise and the role that biology may play in the response of marshes to that rise. Specific research activities this year included:

1. Continued long-term studies of effects of sea-level change and disturbance on salt marshes. This work included continuation of pumping experiment, elevation measurements, plant biomass studies at multiple marshes, and monitoring vegetation in permanent plots. Also continued network analysis studies. (Christian)

2. Development of global scale observing system for land-based activities as part of GTOS. (Christian)

3. Directed PhD dissertation (Bo Dame) on using marsh ponds as focal ecosystems for food web networks and MS thesis (Mark Keusenkothen) on deer trails as a disturbance mechanism on salt marsh. Began synthesis effort on interannual variation at the VCR. (Christian)

4. Continued to teach classes in ecology and microbiology with emphases on long-term and large scale issues. (Christian)

5. Continued work on spatial and the temporal variation in bacterial communities in response to environmental gradients, the relative importance of organic material vs. local environmental conditions on microbial decomposer communities - a biographic study, and the contribution of organic matter dynamics to salt marsh landscape patterns. (Blum)

6. Continued educational activities: (a) NSF RET - Pam Tegelman (Charlottesville High School), (b) REU student - Laurel Woodworth (crab burrow effect on marsh plant below ground production), (c) undergraduate research project - Minh Hai Tranh Lam - Biogeographic relationship between bacterial and fungal abundance on standing dead marsh plants, (d) supervised two graduate students - Mike Lowit (PhD) and Cassondra Thomas (PhD). (Blum)

7. Initiated studies of the distribution and growth of *Salicornia virginica* in relation to sediment chemistry (NH_4^+, PO_4^{3-}, H_2S, salinity, pH, organic content, Eh, total nitrogen and phosphorus) on mainland and island marshes. (Zieman)

8. Initiated studies of the impact of grazing insects on the salt marsh cord grass *Spartina alterniflora* on island and mainland marshes. (Zieman)

9. Continued work on the impact of fiddler crab (*Uca pugnax*) burrows on pore water chemistry of a Spartinal alterniflora marsh on Hog Island. (Zieman)

Upland:

Our attempt to integrate primary productivity and climatic variables is ongoing. Thus far we have focused on relationships within species and sites. A large number of significant correlations were obtained between climatological variables and indicators of productivity based on bi-monthly climatological variables during the growing season. Both temperature-based and precipitation-based climatological measures showed correlations with productivity in one or more species. The largest number of correlations was obtained for the July-August period (in contrast to May-June and September-October), indicating that this period is especially important in determining annual productivity. We are continuing our analysis of this data (so far over 700 pages of statistical output have been generated) and will be meeting later this year to refine and extend these analyses (Christian, Day, Blum, Young, Brinson, Mills, McGlathery, Zieman, Hayden and Porter).

Initial groundwater studies have shown that as groundwater discharges from the aquifer into low-relief coastal streams, nitrate-N concentrations are reduced by up to 90%. For example, groundwaters typically have 10-15 mg/L nitrate-N as a result of agricultural activity. Stream concentrations are typically 1.5 - 2.0 mg N /L. (Mills)

Plant communities on barrier island dunes can undergo succession but they are also subject to abrupt state changes. Generally, aboveground biomass decreased on all dunes over the six-year period. However, the magnitude of the decrease was least on the oldest dune, where *Schizachyrium* increased. The results suggest that typical succession, with biomass increasing progressively, is not occurring on Hog Island dunes. Correlation analysis indicates that the position of the groundwater free surface may play a major role in determining aboveground biomass levels. Other factors possibly involved are salt and sand deposition by storms, herbivory and changes in biomass allocation aboveground versus belowground. (Day)

There were few significant changes in species composition and dominance in control permanent plots between 1992 and 1998; however, in fertilized plots, *Ammophila breviligulata* cover increased (except on the oldest dune) and *Spartina patens* cover decreased (except on the youngest dune). After seven growing seasons, results suggested more intense negative effects of competition in nitrogen-fertilized plots. Greater cover of *Ammophila* in fertilized plots suggests *Ammophila* is in a better position to compete for light with enhanced aboveground dominance. The hypothesis that, with fertilization, areas that start with different species assemblages will become more similar does not appear to be supported by our study. Diversity was lower in fertilized plots on all but the 1967 dune and diversity decreased most dramatically in fertilized plots on the oldest dune. The increase in total density with fertilization as diversity decreased, coupled with the shifting composition of *Ammophila* and other dominants, appears to support the interspecific competitive exclusion hypothesis. Changes in the positions of free surfaces (groundwater level in particular) appear to influence plant community composition. The decline in *Spartina* density may be at least partially attributed to development of drier conditions on the older dunes. (Day)

In 1991, 150 m^2 plots were fertilized with nitrogen on three dunes on Hog Island to examine plant community response to nitrogen addition. In 2000, the fertilized plots continued to exhibit a positive growth response. Aboveground biomass, belowground biomass, and nutrient content of the experimental plots were quantified to examine the long- term patterns of nitrogen retention in a nitrogen-limited system. Aboveground and belowground biomass was significantly greater in the fertilized plots than in the control plots. Aboveground biomass exhibited was significantly greater in control and fertilized

plots in 1991 than 2000, while the belowground portion exhibited increased biomass in both plots over time. Biomass estimates of all plant components were significantly greater in treated plots. Nitrogen standing crop revealed a similar response to treatment in all plant components. Nitrogen concentrations were not affected by fertilization. (Day)

Stable isotope analysis of blood, muscle, and feathers of coastal Virginia Laughing Gull populations showed that some gulls relied more heavily on estuarine prey, whereas others appeared to consume more foods of marine origin. It is extremely important to account for such dietary variability when assessing trophic linkages in dynamic estuarine systems. (Macko, Erwin)

Comparison of pre-fledged gulls of the Virginia Coastal Reserve population with gulls from a more urban site, Jamaica Bay, New York indicates that the nestlings in Virginia moved to a higher trophic level during the period prior to pre-fledging, but the New York birds do not undergo this dietary change. In both sites, the nestlings consumed more foods of marine origin than freshwater or terrestrial. (Erwin, Macko)

Our test to see whether establishment of a wireless network incorporating Hog Island was possible was highly successful. With the help of the Biological Sciences by Wireless Project we were able to achieve all our goals for connectivity, with development of an 11MBS wireless LAN on Hog Island, linked to the mainland at E1 (2 MBS) speeds. So far, this has allowed us to deploy WWWcams to monitor research sites (http://www.VCRLTER.virginia.edu/wwwcam), receive real-time meteorological data, conduct prototype videoconferencing sessions from the island and to establish working LAN connections on our boats. As part of their project, Tom Williams made diary entries tracking the progress of the system development. The full diary with technical details and photos is available at: http://wireless.oldcolo.com/biology/OysterMenu.htm) (P. Smith, Carlson, Porter).

In response to manipulations of predator populations, significantly more birds nested on Metompkin (+182%) and North Cedar (+122%) than had been the case in the three previous years, and fledging success appeared to be substantially higher. The results were less clear-cut for Wreck, Ship Shoal and Myrtle, where raccoons and red foxes were missing naturally, but all three islands produced young-of-the-year birds. Seven of eight males and three of seven females returned to their home island within 1–14 days (average 5.0 days for both males and females). A fourth female returned home within 19 days. Translocated individuals averaged 750 m of straight-line movement per day between release and return to their home island. One male and one female made repeated over-water crossings between islands. There is north-south differentiation on both the islands and the mainland, with what appear to be northern and southern genetic types. Populations on islands appear to be most closely related to populations on the nearest adjacent mainland. Historically, raccoon dispersal at the landscape level appears to have been predominately from west-to-east and mainland-to-island rather than from north-to-south, between islands. These surveys revealed both the loss of raccoons from Myrtle Island and subsequent recolonization. They also revealed the recolonization of both Metompkin aand North Cedar by raccoons sometime between September and November, and the recolonization of Ship Shoal between February and November. (Moncrief, Dueser, Porter)

Declassified satellite imagery was used to construct graphical depictions of landscapes over the period 1963 through 1999 for Hog Island and Phillips Creek Marsh research sites. The resulting posters are available on the WWW at: http://www.vcrlter.virginia.edu/DataImages/Hog_declass.pdf and http://www.vcrlter.virginia.edu/DataImages/brownsville63on.pdf (Porter, Hayden).

We also participated in the production of an LTER Climate book and Bioscience special issue, each of which is due out in the coming year. (Hayden).

Lagoon:

The overall objective of the lagoonal research is to perform an interdisciplinary study of watershed nutrient inputs, biological transformations and trophic interactions, and water residence times in order to determine the extent to which the lagoon functions as a filter influencing the transport of watershed nutrients to the coastal ocean.

Results of studies on nutrient inputs:

Over a 12 year period, monthly volume-weighted-average concentrations of both NO_3^- and NH_4^+ exhibit marked seasonal cycles ranging from peaks of 31 and 22 μmol L^{-1}, respectively, during July to 9 and 2 μmol L^{-1}, respectively, during January. Absolute concentrations and seasonal variabilities in both species are similar to long-term averages for the NADP's monitoring station at Lewis, Delaware. The annual average wet-deposition flux of atmospheric N at the VCR-LTER was 33 mmol N m^{-2} yr^{-1} (4.6 kg N ha^{-1} yr^{-1}); the corresponding wet flux at Lewis is 39 mmol N m^{-2} yr^{-1}. (Galloway)

Intensive studies on nitrogen deposition to coastal waters indicate that: 1) Reactive nitrogen deposited to the sea surface in the region was dominated by $NH_{3(g)}$ (average 33% of total measured N) and because it exhibited high deposition velocities, it accounted for the largest fraction (average 60%) of the total nitrogen flux. 2) Although particulate NH_4^+ accounted for a large portion of the measured nitrogen species in air (average 30% of total N), it was primarily associated with submicron aerosols with low dry deposition velocities. Consequently, particulate NH_4^+ accounted an average of only 2% to the total nitrogen dry deposition flux. 3) HNO_3 contributed appreciably to total nitrogen concentrations (averae 9.7% of total N) and because it also exhibited high deposition velocities, it represented a substantial portion of the dry nitrogen flux (average 25%). 4) Particulate NO_3^- also contributed considerably to the measured atmospheric nitrogen (average 14.3%). Unlike NH_4^+, however, NO_3^- was associated primarily with larger sea-salt particles with exhibited high deposition velocities, so it contributed approximately 8% on average to the total nitrogen deposition flux. 5) ON_{ws}, ON_{nws}, and NO_2^- were present in small quantities in the atmosphere (representing a total of 3.6% on average) and contributed only minorly to nitrogen deposition (5% of the total). 6) The dry deposition fluxes of atmospheric N to coastal waters during the period of the experiment were approximately equal to the corresponding wet-deposition fluxes via precipitation. 7) Atmospheric deposition may be a particularly significant source of nitrogen for primary production in shallow coastal lagoons at the mid-Atlantic U.S. coast during the summer as nitrogen inputs from other new sources are small. (Galloway

Monitoring of 14 creeks draining 14 individual watersheds on the Delmarva Peninsula indicate: 1) a pattern of higher average nitrate concentrations in base flow in upper Delmarva Peninsula creeks (Modest Town to Chincoteague; n=5 creeks) than middle (Exmore to Melfa; n=3 creeks) and lower Delmarva creeks (Simpkins to Nassawadox; n=6 creeks). 2) a significant regression relationship between percent forest cover in watershed and mean nitrate concentration in base flow for the nine middle and lower Delmarva creeks, with lower nitrate in watersheds with higher percent forest cover. (Anderson)

Results of biological process studies in Hog Island Bay that influence nitrogen transformations, plant and animal community composition:

Studies of microbially-mediated transformations of dissolved organic matter in the water column showed that: 1) dissolved organic carbon (DOC) was more labile in Hog Island Bay after the mid-summer macroalgal bloom and crash than during other seasons. 2) There was no difference in dissolved organic nitrogen (DON) lability between seasons or along the across the lagoon transect from land to sea. 3) DOC was utilized 4-5 times faster than DON. 4) Rates of gross mineralization were approximately 8 times higher than rates of net mineralization indicating rapid bacterial consumption of the ammonium produced by mineralization. 5) Nitrification was a significant fate of the ammonium produced. 6) DOC was more labile in Hog Island Bay than in Plum Island Sound (PIE LTER), which has predominantly allochthonous organic inputs. (Anderson, McGlathery)

Studies of photodegradation of dissolved organic matter (DOM) in Hog Island Bay waters and groundwater source waters indicated that photoproduction of ammonium and of the dissolved free amino acids Glycine and Alanine (from groundwater sample) occurred, but at rates that were minor relative to other nitrogen sources and fluxes within the system. DON, nitrate and urea were not produced, but DOC concentrations dropped, resulting in decreased C/N for DOM for some samples, which may influence its lability for water column bacteria (McGlathery)

Benthic algae (micro and macro) influence the exchange of nutrients between the lagoon sediments and the overlying water column. Where microalgal activity made the sediments net autotrophic, total dissolved nitrogen fluxes, mostly dissolved inorganic nitrogen (DIN), urea and dissolved free amino acids, were directed into the sediments. Heterotrophic sediments, particularly beneath macroalgal mats, were a net source of total dissolved nitrogen, mostly DIN. Isolated crashes of dense macroalgal mats led to huge DIN and DON release. When present, living macroalgae dominated benthic-pelagic coupling by intercepting DIN, urea and dissolved free amino acid effluxes and releasing DON, mostly as dissolved combined amino acids. Macroalgae release ~50% of total N uptake. On short time scales, macroalgae act as a conduit whereby both organic and inorganic N are taken up, transformed, and re-released to the water column. This suggests that algal N turnover is higher than previously thought. (McGlathery)

Increased algal biomass in enclosure/exclosure experiments resulted in a decrease in the density of amphipods, clams, crabs and snails. At average algal density amphipods disappeared and at the highest algal density (>5000 gww/m2), crabs and snails disappeared. No change in the density of shrimp and worms was observed with increased algal biomass. Unlike previous studies, we found no shift from dominance of infauna to epibenthic macrofauna. Species diversity was similar among treatments except at the highest algal density where diversity was lower. (McGlathery)

Grazing of the macroalga, *Ulva lactuca*, by amphipods was much greater than of *Gracilaria tikvahiae*, which may, in part, account for the greater abundance of *G. tikvahiae* at the mid-lagoon shoal sites. There was no measurable grazing at algal densities above 1500-g $WW \bullet m^{-2}$, which is much lower than the field average macroalgal density of 3000-g $WW \bullet m^{-2}$. This indicates that macroalgal growth outstripped grazing at a fairly low macroalgal density. (McGlathery)

Results on water residence time in Hog Island Bay:

A 2 dimensional finite element hydrodynamic model coupled with a particle tracking model was run for about 30 days with 705 drogues. Using real water level and wind data from the summer of 2000. After 59 tidal cycles, 475 of the initial 705 drogues were

flushed out of the Bay. Shallow area velocities were strongly affected by the wind, channel areas were less affected.

Marsh:

Findings from experiments and monitoring on mainland and island marshes included the following: 1) Deer trails locally alter primary producer and consumer community structure. 2) Saltmarsh ponds showed huge variation in foodweb and community structure resulting from the drought conditions. 3) Interannual variation in salt marsh end-of-the-year biomass could not be easily explained by differences in rainfall patterns, but a more complex relationship appears present. 4) Mid-marsh accretion may help to dome some marshes and promote ponding in the high marsh and hollow and hummock transition and state change. (Christian, Brinson, Blum)

Microbial communities associated with standing dead marsh grass litter vary more with the plant species than with the geographical location across 10 sites from Maine to south Florida, although sediment communities seem to vary along a latitudinal gradient. (Mills, Blum)

Community DNA cross-hybridization assays showed clear spatial variation in the genetic composition and diversity of bacterioplankton assemblages collected along equivalent longitudinal transects - freshwater to marine (i.e., 0 to 30 PSU) - of a coastal lagoon estuary and a nearby coastal plain estuary. Results supported the hypothesis that community composition changed, in transit through the estuary, in response to environmental variation rather than sharing a common spatial structure caused by hydrological processes. Direct comparisons of community composition and diversity of the two creeks clearly reflected the observed spatial structure within each creek. Communities were most similar to their analogous counterpart (same salinity), however, the degree of similarity differed among these pairs. The estuaries showed >60% similarity between each other when either freshwater or marine communities were compared and but only <30% similarity when intermediate salinity stations were compared. These results demonstrate that environmental heterogeneity in these two estuaries resulted in similar spatial structures but local factors seem to cause differences in the community that develops in the middle estuary stations. Overall, these results demonstrate that with-creek and cross-creek comparisons of bacterial dynamics could be confounded if spatial structure is not considered. (Blum)