FIFTH ANNUAL RESEARCH SYMPOSIUM
UNIVERSITY OF MAINE
INSTITUTE FOR
QUATERNARY STUDIES

Thurs.-Fri.
MAY 8-9, 1997
0830-1700

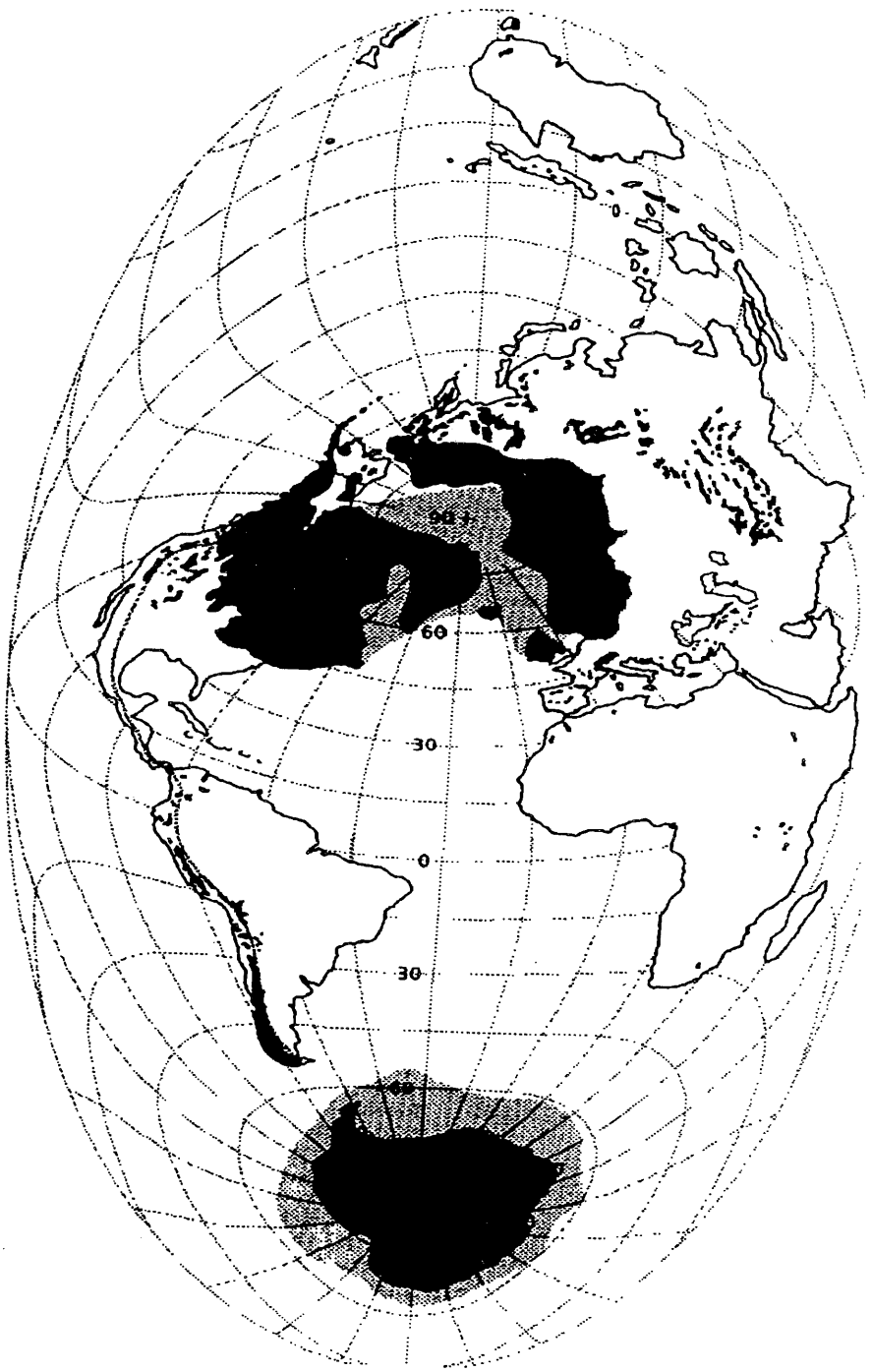
WOOLLEY ROOM
COMMUNITY
CENTER

DORIS TWITCHELL
ALLEN VILLAGE

UNIVERSITY OF
MAINE

ORONO, ME

Presentations by:
University of Maine
Faculty, Staff and
Students and
Maine Geological
Survey Scientists



FIFTH ANNUAL UNIVERSITY OF MAINE
QUATERNARY RESEARCH SYMPOSIUM

DORIS TWITCHELL ALLEN VILLAGE: WOOLLEY ROOM
THURSDAY-FRIDAY May 8-9, 1997

PROGRAM

THURSDAY, MAY 8

0830: **COFFEE**

0855: **WELCOME AND INTRODUCTION: Daniel F. Belknap**

SESSION 1 - ANTHROPOLOGY AND ARCHAEOLOGY

0900: **Bret Achorn**, ISOLATION OF HUMAN MITOCHONDRIAL DNA FROM ANCIENT BONES (ca. 3000 YEARS BP) EXCAVATED FROM THE BIBLICAL CITY OF HEBRON

0920: **Jeff Sommer**, ANOTHER LOOK AT SHANIDAR IV THE NEANDERTAL "FLOWER BURIAL"

0940: **Catherine Chmidling**, IDENTIFICATION AND DISTRIBUTION OF APACHE CANYON CHERT

1000: **Kristin Sobolik**, CULTURAL VERSUS NON-CULTURAL BONE: A CASE STUDY FROM TEXAS

1020: **COFFEE BREAK**

SESSION 2 - MODELING AND DATING

1040: **Doug Introne**, A TECHNIQUE FOR AVERAGING RADIOCARBON DATES:

1100: **Jim Fastook**, EISMINT INTERCOMPARISON EXPERIMENT: COMPARISON OF EXISTING GREENLAND MODELS

1120: **Kirk Maasch**, SIMULATING THE CLIMATE OF NORTHEASTERN NORTH AMERICA WITH A NESTED REGIONAL CLIMATE MODEL

SESSION 3 - PALEOECOLOGY

1140: **Patricio Moreno**, VEGETATION AND CLIMATE CHANGE DURING THE LAST GLACIAL MAXIMUM AND THE TERMINATION OF THE LAST ICE AGE IN THE CHILEAN LAKE DISTRICT

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1200: **LUNCH Doris Twichell Allen Village**

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1300: **Ron Davis**, FIELD WORK IN 1996-97 ON A PALEOECLOGY/PALEOCLIMATOLOGY PROJECT IN DOMINICA, WEST INDIES

1320: **Richard Jack**, THE PALEOECOLOGICAL HISTORY OF APPLETON BOG, MAINE, WITH PRESERVE MANAGEMENT RECOMMENDATIONS

1340: **Dawn Cameron**, PLATEAU BOG DEVELOPMENT IN COASTAL MAINE

1400: **George Jacobson**, LATE-GLACIAL STRATIGRAPHIC RECORDS FROM TWO SITES IN THE FLORIDA HIGHLANDS INDICATE A PRONOUNCED DRY EVENT DURING THE YOUNGER DRYAS CHRONOZONE

1420: **COFFEE BREAK**

SESSION 4 - QUATERNARY GEOLOGY

1440: **Kirk Lurvey**, SENSITIVITY OF THE LAURENTIDE ICE SHEET TO CLIMATE CONDITIONS DURING THE DEGLACIATION OF MAINE

1500: **Meredith Kelly**, A COMPARISON OF DEGLACIATION CHRONOLOGIES FOR COASTAL NEW ENGLAND AND ADJACENT ATLANTIC ENVIRONMENTS: TESTING THE INFLUENCE OF LARGE ICE SHEETS ON NORTH ATLANTIC CIRCULATION

1520: **Tom Kellogg**, LATE PLEISTOCENE INTERACTIONS OF EAST AND WEST ANTARCTIC ICE FLOW REGIMES: EVIDENCE FROM THE MCMURDO ICE SHELF

1540: **Hal Borns**, THE PINEO RIDGE MORAINE COMPLEX COASTAL MAINE, REVISITED

SESSION 5 - ARCHAEOLOGY AND GEOARCHAEOLOGY

1600: **Dan Sandweiss**, EARLY MARITIME ADAPTATIONS IN SOUTH AMERICA

1620: **Heather McInnis**, SUBSISTENCE AND MARITIME ADAPTATIONS AT QUEBRADA JAGUAY CAMANA, PERU; A FAUNAL ANALYSIS

1640: **Stacy Shafer**, BEACH RIDGES SEQUENCES IN NORTHWEST PERU: MONITORING COASTAL CHANGE THROUGH REMOTE SENSING

FRIDAY, MAY 9

0830: **COFFEE**

0855: **WELCOME AND INTRODUCTION: Daniel F. Belknap**

SESSION 6 - ARCHAEOLOGY AND GEOARCHAEOLOGY

0900: **David Sanger**, ARCHAEOLOGICAL INVESTIGATIONS IN THE MILFORD RESERVOIR, MAINE-AN INTRODUCTION

0920: **Karen Mack**, THE MILFORD RESERVOIR, MAINE: 8,000 YEARS OF PREHISTORIC HABITATION

0940: **Alice Kelley**, GEOARCHAEOLOGICAL INVESTIGATIONS, MILFORD RESERVOIR, MAINE

1000: **Bonnie Newsom**, PREHISTORIC NATIVE AMERICAN OCCUPATION AND UTILIZATION OF THE LOWER PISCATAQUIS RIVER VALLEY, CENTRAL MAINE

1020: **Rick Will**, ARCHAEOLOGY IN THE DRAW DOWN ZONE OF NORTHERN RIVERS AND LAKES

1040: **COFFEE BREAK**

SESSION 7 - PALEOCEANOGRAPHY

1100: **Cinzia Spencer-Cervato**, CHANGING DEPTH DISTRIBUTION OF GLOBAL HIATUSES DURING THE CENOZOIC: VARIABLE SEA LEVEL AND DEEP-WATER FLOW MECHANISMS

1120: **Jim Wright**, TRACKING THE ELUSIVE LOW SALINITY SURFACE WATER IN THE GLACIAL NORTH ATLANTIC

1140: **Marianne Lagerklint**, A SEARCH FOR HOLOCENE CLIMATE VARIATIONS - IN THE NORWEGIAN-GREENLAND SEAS

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1200: **LUNCH Doris Twichell Allen Village**

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1200: **POSTER SESSION**:

1. **Ann Boudreaux**, THE STUDY OF PALEOPHARMACOLOGY

2. **Riley Brown**, HOLOCENE CLIMATE RECONSTRUCTION USING HYDROLOGIC CHANGES AT HATCH POND, MAINE, USA

3. **Ann Dieffenbacher-Krall**, CORRELATION OF WATER DEPTH AND THE OCCURRENCE OF VASCULAR PLANT SPECIES IN ALKALINE LAKES OF NEW ENGLAND

SESSION 8 - COASTAL MARINE GEOLOGY

1300: **Joe Kelley**, THE PENOBSCOT BAY PROJECT: SEAFLOOR MAPPING

1320: **Claire Kiedrowski**, UPDATE ON MAPPING THE SALT MARSHES OF WELLS, MAINE

1340: **Dan Belknap**, DEVELOPMENT OF THE MAINE INNER SHELF: NEW CORES AND SEISMIC PROFILES CONFIRM LANDWARD RECYCLING OF QUATERNARY SAND

SESSION 9

1400: **Thomas D. Henze**, THE LITHOSTRATIGRAPY OF PEAKED MOUNTAIN POND: AN INITIAL ASSESSMENT

1420: **Terry Hughes**, STUDYING A CALVING GLACIER ON DECEPTION ISLAND, ANTARCTICA

SUPPLEMENT
Thursday @ 1420

LATE-HOLOCENE DEVELOPMENT OF SPRUCE-FIR FORESTS ON COASTAL MAINE ISLANDS -- A PROGRESS REPORT

Molly Schauffler, Institute for Quaternary Studies and Department of Plant Biology and Pathology University of Maine, Orono, ME. Molly@maine.maine.edu

Regional pollen records from lakes and bogs throughout Maine indicate that spruce and fir became dominant in the region only in the last 1000 years. This recent expansion appears to be part of a large regional expansion of southern populations of spruce across eastern North America, presumably as the climate cooled. Where did the southern populations of spruce occur in Maine during the mid-Holocene? I am comparing fossil pollen and charcoal records from forested wet hollows in spruce stands in Acadia National Park, Roque Island, and Hog Island with those from inland sites in Big Reed Preserve, Penobscot Experimental Forest, and the University of Maine Forest Preserve to test the hypothesis that during the warmer mid-Holocene, spruce was predominant along Maine's coast, but not inland. This is a progress report; I will (1) present preliminary data that show the timing of development of coastal and inland spruce stands and (2) will describe my efforts to determine how accurately pollen deposition in forested sites represents the species present in the local stand.

ABSTRACTS
in Alphabetical Order

ISOLATION OF HUMAN MITOCHONDRIAL DNA FROM ANCIENT BONES (CA. 3000 YEARS BP) EXCAVATED FROM THE BIBLICAL CITY OF HEBRON

Bret A. Achorn, Institute for Quaternary Studies, Univ. Maine. [dwrigh51@maine.maine.edu]

The analysis of DNA from ancient human bones and other tissues has provided significant data in recent years. Results are important for anthropology, forensics, molecular evolution, and the determination of phylogenetic affiliations. Current practices involving the extraction of DNA from ground bone powder often require that sophisticated validation procedures be performed on recovered sequences. Human remains, excavated from the Biblical city of Hebron on the West Bank, have yielded mitochondrial DNA of 121 base pairs in length through the use of chiurgical extraction techniques which may prevent contamination of samples by extraneous DNA. Furthermore, it is shown that DNA may be obtained from a bone specimen of virtually any size, greatly expanding the number of available sources for genetic information from our ancient ancestors.

DEVELOPMENT OF THE MAINE INNER SHELF: NEW CORES AND SEISMIC PROFILES CONFIRM LANDWARD RECYCLING OF QUATERNARY SAND.

Daniel F. Belknap, Dept. Geological Sciences, SMS, and IQS, Univ. Maine, belknap@maine.maine.edu, **Joseph T. Kelley**, jtkelley@maine.maine.edu, and **Stephen M. Dickson**, stephen.m.dickson@state.me.us, **Walter A. Barnhardt**, U.S. Geological Survey, Menlo Park, CA, walterb@octopus.wr.usgs.gov, and **Gregory T. Miller**, Dept. Geological Sciences, Univ. Maine.

The Maine inner shelf contains reworked Wisconsinan glacial and glaciomarine sediments, early Holocene lowstand shoreline and paleodelta deposits, and incised valley fill, thus forming a palimpsest. Bedrock headlands and islands frame embayments that trap sands in the southwestern part of the Maine coast, producing barrier spits and tidal delta complexes. Recent vibracoring (25 cores in 1996) and seismic relfection profiling in three embayments demonstrate a rangae of environments depending on the degree of exposure to waves and tidal current, input of sediment from rivers (Saco and Kennebec Rivers), and local eroding sources of sand. The sandy shoreface near Cape Samll, which protrudes into the Gulf of Maine, is highly exposed, lies at the mouth of the Kennebec River (maine's largest) and apparently receives sand from erosion of older deltaic and transgressive estuarine deposits offshore. Saco Bay is relatively deeply embayed and more protected from high-energy waves, and is dominated by the input of sediments from the Saco River. Wells Embayment is neither protruding nor deeply embayed, and has no major river input. It owes its barrier-backbarrier system to eroding outwash plain, moraines and drumlins. Although cycles of erosion are clearly evident in all three embayments, we find no evidence for offshore buildup of sand offshore, as called for in the Bruun Rule. Rather, the nearshore wedge is thin, and disappears at 15-25 m depth into a shelf surface dominated by patches of sand and gravel with 1-2 m wavelength oscillatory ripples, suggestive of extensive reworking by combined storm flows in depths from 20-50 m. Loss of sand offshore is problematical - cores in deep basin seaward of the sandy beaches are uniformly muddy, with less than 1% sand content. The nearshore sands appear to have been efficiently recycled landward during the Holocene transgression.

THE PINEO RIDGE MORAINE COMPLEX, COASTAL MAINE, REVISITED

Harold W. Borns, Jr., Institute for Quaternary Studies and Dept. of Geological Sciences, Univ. Maine. [borns@maine.maine.edu]

As now defined the Pineo Ridge Moraine Complex, marking the northern edge of 20 km - wide coastal grounding line moraine belt, is a much narrower belt of moraines and ice-contact deltas. It extends for at least 150 km eastward from the Cherryfield area of Maine, and marks the termination of the Pineo Ridge Readvance at about 13,500 yrs. B.P. The recessional grounding line moraine complex in southeastern Maine and New Brunswick documents a fluctuating northward retreat of the ice margin and accompanying marine transgression followed by a significant temporary readvance to form the Pineo Ridge Moraine System. The pattern stratigraphy and chronology of these coastal moraines, including the Pineo Ridge Moraine Complex, suggests the following: the Late Wisconsinan ice margin, retreating from its' maximum position on the continental shelf, crossed the eastern Maine coast in contact with the transgressing "arctic" sea depositing a 20 km-wide belt of recessional, cross-cutting grounding-line moraines beginning at about 14,000 yrs. B.P. The margin then readvanced a relatively short, distance depositing the Pineo Ridge Moraine System at about 13,500 yrs. B.P. Thereafter, the ice rapidly thinned and the margin retreated very rapidly relative to the prePineo Ridge fluctuating retreat, leaving few if any moraines. These events suggest a general warming followed by a climate cooling causing the Pineo Ridge readvance which, in turn, was followed by a strong, persistent climate warming beginning by about 13,000 yrs. B.P., perhaps correlating with the inception of the Bolling Chronozone warming prominent in Europe.

THE STUDY OF PALEOPHARMACOLOGY

Ann Boudreaux, Institute for Quaternary Studies -Archaeology. [caab@acadia.net]

Paleopharmacology is a synthesis of many disciplines -anthropolgy, archaeology, botany, pharmacology, paleonutrition, paleopathology. In order to better understand the lives of the prehistoric peoples of the world, it is of significance to learn how they dealt with illness and injury, pain and death. Today, we seek and obtain relief of discomfort, surcease of pain and banishment of sickness with hardly a thought. When did we learn to do this? How did we learn what to do? What worked in 10,000 BP that we may have lost or forgotten since? The archaeological record holds a materia medica that belonged to prehistoric humankind. My research goal is to learn some of what our predecessors used, and to establish the degree of efficacy of their remedies.

HOLOCENE CLIMATE RECONSTRUCTION USING HYDROLOGIC CHANGES AT HATCH POND, MAINE, USA.

Riley Brown, [rbrown51@maine.maine.edu], Department of Geological Sciences, **Heather Almquist-Jacobson** [almquist@maine.maine .edu], Department of Geological Sciences and Institute for Quaternary Studies; and **David Sanger**, Department of Anthropology and Institute for Quaternary Studies; University of Maine, Orono.

In order to learn what climate changes took place in the northeast USA during the Holocene, we are attempting to determine the relative rate and magnitude of hydrologic changes. Hatch Pond is a small kettle lake, formed in an ice-block depression within an esker complex, and sealed by marine sediment deposited between 14,000 and 12,000 ybp. Eight sediment cores were taken along a transect from shallow to deep water. Five of these were described in terms of grain size, plant macrofossil content, and sediment type [e.g., clay, sand, algal sediment (gyttja), peat]. Radiocarbon dating of the significant changes in each core may determine the timing of each event, while correlating similar timing and events in multiple cores may determine the rate. Preliminary information from our first data set supports a history of multiple changes in hydrologic balance. Previous to ~8300 ybp. lake level was rising, then it fell, covering almost the entire basin with peat, until ~5000 ybp., when the lake level seems to rise again. There is change from shallow water peat to deep water algal sediment at ~2800 ybp., indicating another rise in lake level, yet most information regarding fluctuations younger than ~5000 ybp. is inconclusive at this time.

PLATEAU BOG DEVELOPMENT IN COASTAL MAINE

Dawn Cameron, Institute of Quaternary Studies, University of Maine, Orono, ME
[dcamer51@maine.maine.edu]

Plateau bogs are a unique type of coastal raised bog distinguished by morphometry, hydrology and plant communities, which, in Maine, are found east of Penobscot Bay. The restricted geographic range of these bogs suggests that higher moisture, temperature and inputs of marine aerosols in coastal regions may be, in part, responsible for their shape. It is not known how plateau bogs develop and what causes their unusual morphometry. Determining the sequence of events that leads to this unique shape has implications for understanding mechanisms of both coastal and inland raised bog development and for predicting the long term stability of these ecosystems. This project investigates a plateau bog in Jonesport, Maine and how its developmental pattern compares to previous studies of other raised bogs. Five peat cores were taken along a transect from the center of the bog to its edge. Stratigraphic markers, such as visible changes in peat type, bulk density, and trends in macrofossil data, are used to reconstruct changes in plant communities and infer past surface conditions. Determining the timing of these changes in five cores using radiocarbon dating and pollen correlation will show whether the changes were synchronous or time-transgressive across the bog, which has implications for determining the importance of allogenic versus autogenic controls in peatland development. Initial results indicate that the transition from open water and fen conditions to bog began at the center approximately 6200 years B.P. and, by 3920 B.P., spread laterally to its modern extent. Following slower initial stages of bog development, lateral expansion rapidly occurred between 4340 B.P. and 3920 B.P. Future work will investigate the onset and spread of plateau conditions during the peatland's bog phase.

IDENTIFICATION AND DISTRIBUTION OF APACHE CANYON CHERT

Catherine Chmidling, Institute for Quaternary Studies, University of Maine, Orono, ME

I will be discussing the identification and distribution of lithic sources in the Big Bend area of the northern Chihuahuan Desert. Despite extensive geologic survey, little work has been done on Burro Mesa and Apache Canyon, which are among the chief areas of interest for archaeology in the region. Apache Canyon quarry is a large, very high quality lithic source in the Northern Chihuahuan Desert. It has been used by native peoples since Paleoindian times (12,000-10,500 BP), and samples are believed to have been distributed by humans over much of the area west and north of the Chisos Mountains. I have collected samples from three archaeological sites within the Park, two in the surrounding Eastern Trans-Pecos, and one in northern Cohuilla, Mexico. I am using thin section, electron microprobe, and instrumental neutron activation analyses to determine a signature for the Apache Canyon material, as well as preliminary signatures for the other sources encountered. I will then compare these signatures with the lithic materials recovered from archaeological sites in order to determine the source(s) of the raw material

FIELD WORK IN 1996-97 ON A PALEOECOLOGY/PALEOCLIMATOLOGY PROJECT IN DOMINICA, WEST INDIES

Ronald B. Davis, Dept. of Plant Biology and Pathology and Institute for Quaternary Studies, University of Maine

Dominica, a small volcanic island in the Lesser Antilles is strategically located for study of past vegetation and climate change, including hurricane frequency and related vegetational dynamics in the western tropical Atlantic region. Sea surface temperatures derived from isotope/geochemical studies of corals by Guilderson et al. (1994) at nearby Barbados indicate major changes between 20,000 and 10,000 yr BP. Terrestrial changes to be inferred from recently obtained cores from Fresh Water Lake, a montane volcanic lake in Dominica may confirm the Barbados results, or may indicate a different climate scenario for the region. However, the usefulness of the Dominica cores will depend on dates yet to be obtained, and on stratigraphic resolution of sediment from a polymictic tropical lake with methane generation in sediment. The presentation will discuss goals and approaches, illustrate by video the lake and its surroundings and the coring procedures.

CORRELATION OF WATER DEPTH AND THE OCCURRENCE OF VASCULAR PLANT SPECIES IN ALKALINE LAKES OF NEW ENGLAND

Ann C. Dieffenbacher-Krall, Department of Plant Biology and Pathology, Univ of Maine [io20582@maine.maine.edu]

Paleolimnological studies rely, in part, on the water depth preferences of modern aquatic vascular plants to determine past lake levels. Ancient seeds within lake sediment reveal the presence of plant taxa in the past which are then used as a proxy for water depth. Unfortunately, modern ecological data about most aquatic plant species is inadequate for defining water depth with precision. This study attempts to provide the information needed to improve the usefulness of aquatic plant taxa in reconstructing water depth. By identifying the plants growing in a total of 197 releves in thirteen alkaline lakes located in Aroostook County, Maine, and Berkshire County, Massachusetts, and determining chemical and abiotic conditions within the lakes, I have defined the depth ranges of various aquatic plant species found in these lakes and have examined factors that may affect the depth at which a species grows in a particular lake.

EISMINT INTERCOMPARISON EXPERIMENT: COMPARISON OF EXISTING GREENLAND MODELS.

James L. Fastook, Dept. Computer Science and Institute for Quaternary Studies, University of Maine, Orono. [shamis@gandalf.umcs.maine.edu]

The objective is to compare the different existing ice sheet models when they are applied to the Greenland Ice Sheet. This comparison of models has previously been done with idealized settings (Huybrechts, 1996). Three models scenarios are run: 1) Steady state: Beginning with the current configuration the model is run forward in time until the change in volume less than 0.01 percent in 10,000 years. 2) Last glacial cycle: Beginning with the ice sheet configuration obtained with the steady-state run, a temperature forcing designed to represent a glacial cycle is applied. The forcing in temperature is derived from the GRIP ice core (Dansgaard, 1993, Johnsen, 1995). The simulation starts at 250,000 BP, but only the last 130,000 years will be compared. 3) Greenhouse warming: Beginning with the ice sheet configuration obtained with the last-glacial-cycle run, a climate scenario similar to the result of Manabe and Stouffer (1994) in the case of a 2 X CO2 is applied. Starting at 0 and running until 80 years, the temperature increases with a rate 0.035 °C/year (2.8 °C for 80 years). From 80 to 500, the warming rate is 0.0017 °C /year °0.714 °C for 420 years. The total temperature increase is 3.514 °C. Results will be presented and compared at a workshop to be held in Grundelwald, Switzerland on 25-26 September 1997.

THE LITHOSTRATIGRAPHY OF PEAKED MOUNTAIN POND: An initial Assessment

Thomas D. Henze, Institute for Quaternary Studies, University of Maine, Orono, Maine.

For research sites in the Canadian Maritime Provinces and eastern Maine, radiocarbon dates obtained for subaerial organic deposits buried by inorganic sediments (Mott and Stea, 1993), and for plant macrofossils from lake sediment cores (Mayle *et al.*, 1993), document a widespread change in lithology, (and associated loss-on-ignition data), occurred during the Younger Dryas Chronozone. Spear *et al.* (1994) studied lacustrine sediment accumulated during the Younger Dryas Chronozone in the White Mountains of New Hampshire and found neither a change in the lithostratigraphy, nor variations in biostratigraphy consistent with a climatic reversion. Lake sediments from southern New England contain evidence for a biostratigraphic change, but not a lithologic change, during the Younger Dryas Chronozone (Peteet *et al.*, 1993).

Peaked Mountain Pond is located west of New Brunswick and northeast of New Hampshire at 440 meters elevation; yet, its stratigraphy appears similar to that found in the maritime province ponds. It is important to know if the various lithologies deposited at Peaked Mountain Pond were contemporary with those they resemble from New Brunswick. Identifying which physical processes are most likely to have caused the accumulation of the various lithologies is equally important. The contrast between late-glacial lacustrine sediment records from these adjacent regions could depend on the local predominance of different physical processes. Seismic profiling, piston-coring, and x-radiography are methods I have used to learn how the various lithologies within the stratigraphic section, seen in the array of sediment cores from Peaked Mountain Pond, are related. Some of the stratigraphy suggests lake water level changes.

STUDYING A CALVING GLACIER ON DECEPTION ISLAND, ANTARCTICA

Terry Hughes, Institute for Quaternary Studies and Dept. of Geological Sciences, Univ. of Maine, Orono, Maine

Abrupt climate changes recorded in the GRIP and GISP-2 coreholes through the Greenland Ice Sheet have renewed interest in mechanisms for rapidly advancing and retreating the margins of Quaternary ice sheets. The most rapid retreat mechanism is calving of ice along marine and lacustrine margins of these ice sheets. A workshop on calving glaciers, funded by NSF, was sponsored by The Ohio State University from 28 February to 1 March, 1997. The University of Maine's contribution to the workshop was a presentation of the first comprehensive study of a calving glacier that resulted in discovering the calving mechanism and formulating a calving "law" for glaciers calving in water of variable depth along a grounded ice wall. The study was made on Deception Island, off the Antarctic Peninsula, following the 12 August 1970 volcanic eruption. The eruption created a crater at the snout of a glacier, thereby producing a calving ice wall that advanced across the crater in succeeding years. Surface strain networks were emplaced to study ice flowing toward the ice wall, and tunnels were dug into the ice wall at various heights to study calving along the ice wall. Calving took place along ring faults traversed by the strain networks. Bending shear bands rising nearly vertically from the glacier bed to the faults, like shear between the pages of a book bent around its binding, caused the ice wall to lean forward and crevasses to open along the ring faults. Slabs calved as the crevasses approached the ice wall. Shear deformation was studied in the tunnels and ice samples were removed for determining crystal fabrics and for duplicating the stress conditions in laboratory creep experiments. This led to developing the calving "law".

A TECHNIQUE FOR AVERAGING RADIOCARBON DATES:

Douglas "Cap" Introne, Stable Isotope Laboratory, Sawyer Environmental Research Center, Univ. of Maine. [introne@maine.maine.edu]

Multiple measurements of ^{14}C activity and averaging of calculated ages from a single archeologic or geologic event (moment in time) improves the precision of the dating of that event. A practical technique for interpreting arrays of radiocarbon dates is discussed. Various methods are demonstrated including weighted averaging, statistical rejection of data using Chauvenet's criterion and the evaluation of contemperaneity. Actual examples are worked out to illustrate these procedures. These methods are simple and invaluable to all quaternary scientists and students.

THE PALEOECOLOGICAL HISTORY OF APPLETON BOG, MAINE, WITH PRESERVE MANAGEMENT RECOMMENDATIONS

Richard Jack, Ecology and Environmental Science Program, University of Maine, Orono, ME 04469

The Nature Conservancy of Maine (TNCM) owns and manages the Appleton Bog Preserve in Knox County, Maine (44°20′ N, 69° 16′ W), the northernmost Atlantic white cedar (Chamaecyparis thyoides) stand. Logging around 1865 led to the development of the current stand whose trees range between 105 and 130 years old. The species is early successional and outcompeted by associated hardwoods in the absence of stand replacing fires or disturbance. In an effort to preserve this outlier population from future logging threats, TNCM began acquiring portions of the wetland through donations and purchases in 1976. The Nature Conservancy currently has a low input management strategy at Appleton Bog focusing on preservation. Because of the advanced age of the trees, the perpetuation stand may require an active management disturbance regime in the future. This study seeks to elucidate the environmental conditions which led to the establishment of cedar at Appleton Bog and to determine the disturbance patterns that have maintained the community. To accomplish this, I will reconstruct the paleoecological history of Appleton Bog using macrofossils, pollen and charcoal from peat cores. Knowledge of previous stand origins, disturbance and conditions will then serve to develop a management strategy consistent with the biotic and abiotic factors that have perpetuated the cedar population to date.

LATE-GLACIAL STRATIGRAPHIC RECORDS FROM TWO SITES IN THE FLORIDA HIGHLANDS INDICATE A PRONOUNCED DRY EVENT DURING THE YOUNGER DRYAS CHRONOZONE

G. L. Jacobson, Jr., Almquist-Jacobson, H., Dieffenbacher-Krall, Ann. Institute for Quaternary Studies, University of Maine, Orono, ME 04469 [jacobson@maine.maine.edu]

An early pollen stratigraphy from Lake Tulane, located on the southern portion of the mid-Florida highland ridge, suggested wet/dry oscillations between 10 ka BP and 50 ka BP, apparently corresponding in time to Heinrich events in the North Atlantic. Analyses of new cores from the site provide multiple lines of independent evidence to assess the paleohydrology of the site. Pollen analysis, lake-level reconstructions based on sedimentology of cores from different depths in the lake, and analysis of charcoal in the sediments all contribute to understanding of the regional changes in climate. The moisture balance during the period surrounding the Younger Dryas chronozone is of particular interest in this region because variations in tropical and sub-tropical water vapor have been hypothesized as a part of the mechanism responsible for the millennial-scale climate oscillations of the late Quaternary. Evidence from the recently collected Lake Tulane cores suggests a sharp change to dry conditions that persisted between 11,000 BP and 10,000 BP. Paleoceanographic data from several sites in the Gulf of Mexico indicate that the waters of the Gulf became cooler during the same period.

GEOARCHAEOLOGICAL INVESTIGATIONS, MILFORD RESERVOIR, MAINE

Alice Kelley, Dept. Geological Sciences, University of Maine. [arkelley@maine.maine.edu]

The geoarchaeological investigations which have been undertaken in the Milford Reservoir area illustrate the wide range of topics which come under the heading of "geoarchaeology". Studies of the stratigraphy at individual sites has contributed information relating to Late Pleistocene and Holocene fluvial conditions in the area, as well as the geologic setting of archaeological sites at the time of their occupation. Comparison of geologic data gathered at sites throughout the region has aided in a further understanding of site location and preservation models. By combining the extensive Gilman Falls stratigraphic record with a water balance history developed for the region, links have been made between climate and the Late Holocene sedimentary history of the study area. Geologic mapping and careful lithologic analysis of artifacts from the Gilman Falls site support recognition of the site as a Middle Archaic quarry/workshop location. Geoarchaeology has been an important component of the interdisciplinary approach to understanding the prehistory of the region.

THE PENOBSCOT BAY PROJECT: SEAFLOOR MAPPING

Joseph T. Kelley, Maine Geological Survey, Augusta, ME 04333. [jtkelley@maine.maine.edu]

The National Environmental Satellite Data and Information Service of NOAA and the Island Institute are supporting a multi-year, multi-disciplinary study of Penobscot Bay. The goal is to better manage the bay's natural groundfish resources and aquaculture potential by understanding how the ecosystem works. Research on primary and secondary productivity, physical circulation and historic fish-spawning grounds are part of the project. I have been involved in mapping the seafloor with side scan sonar to define the seafloor habitats that will be investigated by benthic biologists. Focus has been placed on many gas-escape pockmark fields in the upper bay that may have hosted bogs and lakes during times of lower sea level. Additional interest is placed on the canyon system in the outer bay, and its origin. Work this summer will include a week with a remotely operated vehicle, seismic reflection profiling and modeling of the habitats with a geographic information system.

LATE PLEISTOCENE INTERACTIONS OF EAST AND WEST ANTARCTIC ICE FLOW REGIMES: EVIDENCE FROM THE MCMURDO ICE SHELF

Thomas B. Kellogg, [tomk@iceage.umeqs.maine.edu], **Terry Hughes**, and **Davida E. Kellogg**, Department of Geological Sciences and Institute for Quaternary Studies University of Maine, Orono, ME 04473

In a recent paper in the Journal of Glaciology, we present new interpretations of deglaciation in McMurdo Sound and the western Ross Sea, with observationally based reconstructions of interactions between East and West Antarctic ice at the LGM, 16,000, 12,000, 8000, and 4000 B.P. Here we concentrate on the LGM reconstruction in the McMurdo Sound/Ross Island area. At the LGM, East Antarctic ice from Mulock Glacier split; one branch turned westward south of Ross Island; the other branch rounded Ross Island before flowing southwest into McMurdo Sound. This flow regime, constrained by an ice saddle north of Ross Island, is consistent with the reconstruction of Stuiver and others (1981a). After the LGM, grounding-line retreat was most rapid in areas with greatest water depth, especially along the Victoria Land coast. By 12,000 B.P., the ice-flow regime in McMurdo Sound changed to through-flowing Mulock Glacier ice, with lesser contributions from Koettlitz, Blue, and Ferrar glaciers, because the former ice saddle north of Ross Island was replaced by a dome. The modern flow regime was established ~4000 B.P. Ice derived from high elevations on the polar plateau but now stranded on the McMurdo Ice Shelf, and the pattern of Transantarctic Mountains erratics, support our reconstructions of Mulock Glacier ice rounding Minna Bluff, but with all ice from Skelton Glacier ablating south of the bluff. They are inconsistent with Drewry's (1979) LGM reconstruction that includes Skelton ice in the McMurdo Sound through-flow. Drewry's model closely approximates our results for 12,000-4000 B.P.

A COMPARISON OF DEGLACIATION CHRONOLOGIES FOR COASTAL NEW ENGLAND AND ADJACENT ATLANTIC ENVIRONMENTS: TESTING THE INFLUENCE OF LARGE ICE SHEETS ON NORTH ATLANTIC CIRCULATION.

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Large ice masses have a significant ability to alter oceanic and atmospheric circulation by posing an orographic obstacle to wind patterns. At the present time, the Gulf Stream and the North Atlantic Current (NAC) carry heat to high northern latitudes. The currents travel to >50° north as a result of being influenced by the North American continental shelf, in particular, the bathymetry of the Southeast Newfoundland Rise region. If the flow of the Gulf Stream-NAC system were diverteddd to the south, the currents would likely be uncoupled from the bottom topography and, as a result, may flow in a more east to west direction at lower latitudes across the North Atlantic. During the last period of deglaciation, ~15,000 to 10,000 yrs BP, a strong Jet Stream developed along the southern margin of the Laurentide Ice Sheet (LIS) and may have provided a mechanism to separate the Gulf Stream-NAC system from the bottom topography of the North Atlantic. The proposed project will provide a means to test the interaction between the southeastern margin of the LIS and North Atlantic circulation by 1) augmenting the existing chronology of ice margin positions during deglaciation from Boston to Southern Maine, 2) defining a chronology of change in surface environmental conditions at a strategic location in the North Atlantic, and 3) correlating the chronologies based on radiocarbon dates and assessing the effects of ice margin location on the conditions of North Atlantic surface waters. A radiocarbon chronology of deglaciation will be better refined by taking three to four lake cores along a transect parallel to ice flow, between Boston, MA and Kennebunkport, ME. A record of surface water conditions in the North Atlantic will be determined by analyzing the relative abundances of temperature dependent planktonic foraminifera species, and the oxygen isotope values of these animals' shells, preserved in a deep ocean sediment core. Ocean core RC6-5 has been selected for analysis because of its location, proximal to the New England coast and sensitive to the position of the Gulf Stream.

UPDATE ON MAPPING THE SALT MARSHES OF WELLS, MAINE.

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A purpose of this project is to relate marsh zonation to human influences by mapping five salt marshes in Wells, Maine. At last year's symposium, the procedure for compiling an accurate base map was discussed. The base map consists of four orthorectified photographs, which have been stiched together to produce a digital orthophoto mosaic. This mosaic is used as a raster backdrop for additional vector information. Since this study is a work-in-progress and the second year of mapping has just been completed, the discussion at this year's symposium will focus on the work perfomed to date with emphasis on these topics: (1) description of the physical characteristics of the five salt marshes selected for the study, (2) review of the topographic features collected using traditional surveying techniques, (3) preliminary discussion of the questionable elevations identified on the marsh located north of Drake's Island Road. Tentative plans include integrating data from other researcher's work such as:
a historic map of the Drakes Island Road southern marsh, and using this to compare changes through time, a coordinate map of sediment core data a topographic map of the Wells area for feature and elevation comparison aerial photos of marshes from 1953, 1974 and 1995.

A SEARCH FOR HOLOCENE CLIMATE VARIATIONS - IN THE NORWEGIAN-GREENLAND SEAS?

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The discovery of rapid, frequent climate fluctuations during the last glacial period has raised the question whether such fluctuations also occurred during the Holocene. The Holocene climate has in general been considered to be relatively stable. However, it has been shown that the variability revealed in climate records highly depends on their temporal resolution. Therefore, the stable appearance of Holocene records may be an artifact of the time resolution. Sampling of Holocene sediments with high sedimentation rates at small intervals should facilitate the search for any rapid, frequent climate fluctuations. Also, as the Holocene climate variations were much more subdued than glacial variations, it is important to analyze sediments from a region that is sensitive enough to record small-scale climatic change. The objective for my project is to analyze two deep sea cores with relatively high sedimentation rates in the Norwegian-Greenland Seas. The cores should straddle the present position of the oceanic polar front (ca. 7°C mean annual isotherm) to enable a reconstruction of how the Holocene positions fluctuated with changing climate. This will be achieved by using faunal and isotopic analyses of planktonic foraminifera which indicate sea surface temperatures. The region is known for its generally low sedimentation rates with respect to carbonate. An exception is beneath the relatively warm Norwegian Current where the flux of planktonic foraminifera shells is high. Core descriptions and previously published proxy data, such as oxygen isotope records or percentage $CaCO_3$, are used to assess the suitability of cores for this project. Selected cores that lack previous work have been isotopically analyzed at coarse resolutions to determine the depth of the glacial to interglacial transition (characterized by a large increase in $\delta^{18}O$). To date, analyzed cores north of the polar front have yielded only 20-30 cm of Holocene material.

SENSITIVITY OF THE LAURENTIDE ICE SHEET TO CLIMATE CONDITIONS DURING THE DEGLACIATION OF MAINE

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During the late Wisconsinan, the Laurentide Ice Sheet retreated northwestward across eastern Maine depositing a series of distinct end moraines that record the successive positions of the retreating ice. These end moraines comprise a washboard-like complex that extends from the present Maine coastline to a northernmost position 40 km inland. This study examines the relationship between this extensive end-moraine complex, first identified by Borns (1966) and the area immediately to the north where these moraines are absent. I propose to clearly define this transition zone and examine the possible changes in ice dynamics that are responsible for its formation. I have conducted detailed surficial mapping to establish the locations that best exhibit the distinct change in end moraine morphology. I suggest these glacial deposits reflect a change in ice dynamics following the construction of the coastal end-moraine complex. Possible changes of the ice margin dynamics include (1) Large scale ice stagnation to the north of Pineo Ridge, (2) Rapid ice margin retreat, and (3) Possible control by the upper marine limit. Timing on the deglaciation of the study area is limited. Basal lacustrine sediments from Mountain Pond, located within the transition zone, indicates a short time span of late-glacial sedimentation within the basin. Radiocarbon analysis of this core may allow a more detailed timing on the deglaciation and possible link of ice dynamics to climate conditions during deglaciation of the study area.

SIMULATING THE CLIMATE OF NORTHEASTERN NORTH AMERICA WITH A NESTED REGIONAL CLIMATE MODEL

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General circulation models (GCMs) of the atmosphere are often used to study past, and future, climates. While GCMs are adequate tools for simulation of large-scale global atmospheric conditions, limited spatial resolution inhibits their usefulness in situations where mesoscale processes are important. In order to address this inadequacy it is possible to use a much higher resolution nested regional climate model in conjunction with the GCM, which provides the detailed physics required to resolve smaller spatial scale phenomena. We have simulated the weather conditions in northeastern North America for the winter of 1992-3 with a regional climate model (RegCM2). RegCM2 is a hydrostatic, compressible, primitive equation, terrain following sigma-vertical coordinate model. RegCM2 includes the radiative and boundary layer parameterizations used in version 2 of the NCAR Community Climate Model (CCM2), and the latest version of the Biosphere-Atmosphere Transfer Scheme (BATS). For this simulation, the model domain extends from roughly 62-77 degrees west longitude and 35-55 degrees north latitude (centered on Bangor, ME). The horizontal resolution is 45 km and there are 17 vertical layers. Meteorological initial and lateral boundary conditions necessary to drive RegCM2 were interpolated from the European Center for Medium Range Weather Forecasting (ECMWF) global analysis of observations. To assess the performance of RegCM2 we compare the modeled climate to the ECMWF analysis within the model domain. In the near future we plan to couple the most recent version of the CCM (CCM3) to the RegCM2 mesoscale model to study millennial scale climate change, including the glacial-interglacial transition, in northeastern North America. This will require an ice sheet model (which for us means it will require Jim Fastook, with whom we will collaborate).

THE MILFORD RESERVOIR, MAINE: 8,000 YEARS OF PREHISTORIC HABITATION REVEALED.

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The culture history of Maine is traditionally divided into 4 periods which are further subdivided into stages (e.g. Early, Middle and Late). From earliest to latest they are: Paleoindian (11,500 - 9,500 B.P.), Archaic (9,500 - 3,000 B.P.), Ceramic (3,000 - 450 B.P.) and Contact Period (450 - 200 B.P.). On going archaeological research in the Milford Reservoir has allowed us to broaden our understanding of the definition, spatial and temporal extent of these taxonomic units.

To date 5 sites have been extensively excavated in the area of Pushaw stream and its confluence with the Stillwater River. An 8,000 year old occupation, associated with the Early Archaic Period, has been identified on a portion of the beaver site, located on the Stillwater River. Excavations at the Gilman Falls site, immediately downstream of the Beaver site, revealed a prehistoric quarry and habitation site dated to between 7300 - 6300 B.P., the Middle Archaic Period. The Hirundo site, located on Pushaw Stream, has provided additional evidence of Middle Archaic occupation of the area. Features and artifact assemblages related to Late Archaic Laurentian and Susquehanna traditions exist at the Hirundo, Young, and Bob sites. Both the Bob site and the Beaver site were heavily utilized during the Ceramic Period. Well defined stratigraphy at each of these sites has allowed the delineation of Early, Middle and Late Ceramic Period occupations. Artifact assemblages recovered from the upper strata at the Beaver site suggest Contact to Historic Period utilization of the site.

Date gathered from these sites has provided us with insights into previously established models of prehistoric settlement patterns, resource exploitation and culture history.

SUBSISTANCE AND MARITIME ADAPTATIONS AT QUEBRADA JAGUAY, CAMANA, PERU: A FAUNAL ANALYSIS

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I will present the objectives, research strategy, methods, and preliminary results of my current investigation of vertebrate faunal remains excavated from Quebrada Jaguay (Site QJ 280), an Early Preceramic site on the south coast of Peru. The overall purpose of the proposed study is to investigate and describe the subsistence base and maritime adaptations of early Prehistoric populations from the south coast of Peru. This research addresses several questions: first, what species and habitats were commonly exploited by the site inhabitants, and what technology was used to procure these resources? Second, what classification can be assigned to the site according to its cultural features? It is a resource processing center, residential, or religious site? Third, do changes in the faunal assemblage throughout the stratigraphic record indicate cultural (socio-economic, subsistence or settlement) and/or environmental changes at this site? Fourth, what factors have influenced the preservation of the recovered faunal material? Erosion, depth of burial, climate and cultural practices such as processing techniques, will be taken into account. And fifth, can the seasons of site occupation be identified based on the faunal data? The study will provide insights concerning the earliest Paleoindians utilizing the coast of Peru, and may call into question traditional hypotheses of the peopling of the New World. This thesis will also provide a basis for further investigations of the role of maritime resources in the development of later complex societies.

VEGETATIOIN AND CLIMATE CHANGE DURING THE LAST GLACIAL MAXIMUM AND THE TERMINATION OF THE LAST ICE AGE IN THE CHILEAN LAKE DISTRICT

Patricio I. Moreno, George H. Denton and George L. Jacobson

Radiocarbon-dated pollen records from Canal de la Puntilla (40°57'S, 72°54'W), Lago Condorito (41°45'S, 73°07'W), Huelmo (41°31'S, 73°00'W), and Bella Vista Bluff (41°19'S, 72°58'W) reveal that an open landscape prevailed in the Chilean Lake District between 20.2 and 14.4 ka (ka=10^3 ^{14}C years before present), dominated by *Nothofagus* and Gramineae, along with taxa commonly found today above the Andean treeline, and with patches of Magellanic Moorland. This assemblage suggests cooler temperatures (6-7°C lower than present) and higher precipitation (twice the modern values), suggesting a northward shift and intensification of the westerlies stormtracks at 41°S. Minor climate amelioration occurred between 20.2 and 15.8 ka, interrupted twice by glacial maximum conditions between 19.2 and 18.8 ka, and between 15.8 and 14.8 ka. A major increase in *Nothofagus* started at 14.8 ka, followed by an abrupt expansion of thermophilous North Patagonian Rain Forests at 14.0 ka, suggesting climate warming and the onset of the last termination. The subsequent increase of thermophilous species at about 12.9 ka and disappearance of Magellanic Moorland taxa suggests climate warming and southward migration of the westerly winds. This was followed by a general reversal in trend with cooling events at about 12 and 11 ka. Vegetation disturbance by fire is most prominent near Lago Condorito starting at 11 ka, and near Huelmo beginning at an estimated age of 10.5 ka. The moisture gradient inferred from the pollen records is the inverse of the geographic distribution of charcoal between 11 and 10 ka, suggesting that rainfall seasonality alone cannot account for the onset and maintenance of fire. Pyroclastic flows, or paleoindians activities are plausible mechanisms for fire initiation and persistence between 11 and 10 ka. This research was funded by the National Geographic Society, the Office of Climate Dynamics of the National Science Foundation (NSF), and the EPsCOR program of the National Science Foundation.

PREHISTORIC NATIVE AMERICAN OCCUPATION AND UTILIZATION OF THE LOWER PISCATAQUIS RIVER VALLEY, CENTRAL MAINE

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Historical accounts of Native American settlement patterns in Maine indicate a transhumance from interior sites in the winter to coastal sites in the summer. Extensive coastal research by Sanger has indicated that this interior to coast transhumance was not the settlement pattern of Native Americans prior to European contact. Sanger's research suggests that populations occupying coastal environments were distinct from populations occupying interior environments. To test this model, research is being conducted on cultural remains recovered from several sites located in the Lower Piscataquis River valley in Central Maine. This investigation will provide valuable information on subsistence, settlement patterns, trading networks and ethnic distributions for Maine's prehistoric interior populations. In 1995 and 1996, Bangor Hydro-Electric Company, in cooperation with the University of Maine, conducted archaeological testing of the Howland Reservoir to meet federal guidelines for relicensing the Howland Dam. As a result, 38 sites were located in the Lower Piscataquis River valley. In 1996, initial survey work was followed up with an eight-week excavation of 7 sites. These excavations revealed approximately 3,000 years of Ceramic Period cultural remains. These assemblages, combined with cultural material recovered from the initial survey, will offer a unique opportunity to interpret prehistoric occupation and utilization of Maine's interior by Native Americans. Additionally, this research will add to our limited understanding of ethnic boundaries of Maine's prehistoric peoples.

EARLY MARITIME ADAPTATIONS IN SOUTH AMERICA

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Due to eustatic sea level rise and coastal submergence prior to 5,000 BP, archaeologists have found little evidence of how the earliest people in South America adapted to living along the shore. However, there are a few places along the Pacific Coast where little land was lost beneath the waves, and in those places we have discovered a few sites dating to the time of the first Americans, the Paleoindians (12,000-10,000 years ago). Unfortunately, all but one of these sites have disappeared or been destroyed in the last decade. Last summer I excavated the last of these known sites, Quebrada Jaguay 280. Brief, prior explorations at the site had shown that the inhabitants utilized shellfish from almost 11,000 years ago to about 7,500 years ago. Analysis of excavated materials is on-going, but the following preliminary results are available. Interpretations of these results remain speculative.

1. There is an Early Preceramic (Paleoindian age) component dating between ca. 10,200 and 11,100 BP (uncalibrated), in one sector sealed under a caliche layer; there is also a subsequent Middle Preceramic occupation dating between ca. 9,100 and 7,500 BP (uncalibrated).

2. Throughout both occupations, exploited animal species included fish and mollusks but no terrestrial species. Evidence for plant use is minimal, probably due to poor preservation of uncarbonized soft tissue.

3. Probable postholes from the Early Preceramic component and part of a Middle Preceramic, semi-subterranean, circular house provide evidence for early domestic structures.

4. Throughout both occupations, obsidian from the highlands was used for tool manufacture, though it is rare in comparison to other, possibly local, stone types that include petrified wood.

5. Wool cordage and gourd rind provide rare evidence for use of perishable materials in the Middle Preceramic period. 6. Survey of sites within 5-10 km of Q. Jaguay 280 suggests a change in settlement pattern between the Early/Middle Preceramic (ca. 12,000-5,000 BP) and Late Preceramic (ca. 5,000-3,750 BP) Periods.

ARCHAEOLOGICAL INVESTIGATIONS IN THE MILFORD RESERVOIR, MAINE - AN INTRODUCTION

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The Milford Reservoir research area includes Penobscot, Stillwater and Pushaw Stream waters upstream of dams at Milford and Gilman Falls. Since 1988 the University of Maine, under contract with Bangor Hydro-Electric company, has conducted interdisciplinary research leading to a better understanding of the pre-European period of human history. After the initial reconnaissance which identified 115 new sites in the Milford Reservoir, excavation of a selected number of sites followed. From these emerged an 8,000 year record of habitation. The environmental context for human presence in the area involves analysis of the geological history of the area, from the antecedent geology, up to and involving modern events. Some understanding of local Holocene ecological history also helps set the appropriate context for the hunters and gatherers that lived in the area.

BEACH RIDGE SEQUENCES IN NORTHWEST PERU: MONITORING COASTAL CHANGE THROUGH REMOTE SENSING

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Coastal change represents a dynamic area of geology that occurs on human time scales. The Northwest Peruvian coast is experiencing shoreline evolution as it progrades. Sequences of beach ridge are a result of this progradation and other shoreline processes active by 5000 BP. The ridges are found to the north of four river mouths (Santa, Piura, Chira, Tumbes), and in front of normally dry quebradas at Colan. The El Nino/Southern Oscillation (ENSO) may be linked to this process of beach ridge formation. Every 5-7 years the desert coast of Peru is drowned in ENSO rains as the trade winds weaken. The strong rains are thought to transport sediment down the river valleys into the Pacific Ocean where the material is later worked into beach ridges by longshore drift. This process is aided by tectonic events that loosen sediment. Tectonic activity preceding an ENSO event heightens the ability to build a beach ridge by supplying more material to the system. A remote sensing study around the Santa River mouth found a new beach ridge after the 1972-1973 ENSO, but not after the stronger 1982-1983 ENSO. In 1970 there was a seismic event that registered 7.7 on the Richter scale, but no similar activity between 1972-73 and 1982-83. A remote sensing project is currently being carried out on more northern beach ridge sets, at the Piura and Chira river mouths. I will interpret aerial photos and satellite images from these areas at several time intervals from 1946 to present, and digitally overlay them. The objective is to measure the amount of shoreline progradation, identify changes in the ridge complexes, as well as to recognize any temporal relation of those changes with ENSO and tectonic activity. A model for how modern beach ridges form will be developed and extrapolated back through the Holocene.

CULTURAL VERSUS NON-CULTURAL BONE: A CASE STUDY FROM TEXAS

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For this paper we present research on the problem of identifying bone deposited as a result of human activity versus non-cultural agents. Our case study includes the analysis of bone recovered from a prehistoric rockshelter site in Big Bend National Park, TX. To determine depositional agents of non-cultural bone we analyzed bone from Great-Horned Owl pellets accumulated in a small rockshelter 50 m from the site, bone recovered from carnivore scat dispersed across the surface of the site, as well as the contents of rodent burrows found in site deposits. Analysis of these materials revealed the types of refuse deposited by natural agents in this region for use in comparisons to the types of refuse deposited by humans allowing us to discern which bone in the archaeological site was culturally deposited bone.

ANOTHER LOOK AT SHANIDAR IV, THE NEANDERTAL "FLOWER BURIAL"

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Solecki (1971) and Leroi-Gourhan (1975) have suggested that clumps of pollen recovered in association with the Shanidar IV Neandertal skeleton from Shanidar Cave, Iraq, represent flowers that were placed on and around the body as a funerary rite or offering. Although challenged by some, this interpretation continues to be cited as possible evidence for ritual activities and human-like qualities exhibited by Neandertals. This has in turn been used to support the position of Neandertals as direct human ancestors. Despite claims that animals would have been incapable of depositing flowers and pollen with a buried skeleton, I present evidence that the association of pollen and the Shanidar IV skeleton is more likely a result of the activities of rodents, specifically *Meriones persicus* (persian jird), than of Neandertals. This evidence includes that fact that excavators observed and reported extensive rodent disturbances around the Shanidar IV skeleton. In addition, many rodent specimens are present among the faunal remains recovered from Shanidar Cave, including *Meriones persicus*. Finally, colonies of *Meriones persicus* and other *Meriones* species are known to inhabit caves, burrow into soft substrate, and store vast quantities of vegetation in their burrows. Although circumstantial, this evidence strongly suggests that rodents are indeed responsible for the association of pollen and the Shanidar IV skeleton.

CHANGING DEPTH DISTRIBUTION OF GLOBAL HIATUSES DURING THE CENOZOIC: VARIABLE SEA LEVEL AND DEEP-WATER FLOW MECHANISMS

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The global distribution of unconformities can be used to evaluate the differential effect of climate change, ice-volume fluctuations and oceanic crust tectonics on sea level. This study presents a distribution curve of hiatuses found in globally distributed Cenozoic sediments. Patterns of cyclicity as well as modes of distribution of hiatuses with respect to water depth through time will be discussed. Prior to the early Eocene, eustatic sea-level changes caused by changes in rate of sea-floor spreading and sediment corrosion affected shallow and intermediate water sediments (<3000 m). Glacio-eustatic sea-level changes coupled with progressively more vigorous deep-water circulation caused widespread unconformities in deeper water sediments since the middle Eocene. Isolated intervals of corrosive deep-water pulses during the Oligocene - middle Miocene preceded a more vigorous ocean circulation after the middle Miocene. This latter interval is characterized by nearly synchronous unconformities both in shallow and deep-water sediments, suggesting a causal relationship between sea-level changes and global cooling.

ACHAEOLOGY IN THE DRAW DOWN ZONE OF NORTHERN RIVERS AND LAKES

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A variety of natural processes affect archaeological remains located in the draw down zone of northern impounded rivers and lakes. Wave action entrains stone artifacts in a predictable manner. Stone artifacts become imbedded in grounded ice and can either be pushed or floated to new locations during spring thaw. One approach for understanding and predicting artifact movement in draw down zones acknowledges that once cultural materials enter into a natural system they are subjected to the same dynamic forces that affect all materials in that system. Controlled field experiments and interdisciplinary research designs are two important ways for constructing and testing hypotheses to distinguish cultural and natural events on the shores of impounded water bodies.

TRACKING THE ELUSIVE LOW SALINITY SURFACE WATER IN THE GLACIAL NORTH ATLANTIC

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North Atlantic surface salinity changes are invoked in several climate change hypotheses as triggers for abrupt climate changes. Evidence for cold, low salinity waters covering the northern North Atlantic during the last glacial interval includes faunal and floral evidence and the accumulation of ice-rafted detritus throughout the North Atlantic north of ~40°N. While both are good proxies for low salinity surface waters, neither directly measures surface water salinities. Planktonic foraminiferal $\delta^{18}O$ values offer one of the best tools for estimating past surface water conditions because they directly record the temperature and salinity-induced $\delta^{18}O$ value of the surface water. Downcore stable isotope records from three species in several cores in the northern North Atlantic show that each species recorded differences not only in the magnitude, but also in the timing of climate changes during the last deglaciation, indicating that each taxa recorded different aspects of the surface water environment. The $\delta^{18}O$ patterns from these species observed for the last glacial maximum are consistent with a low salinity cap on the North Atlantic. Estimates based on the planktonic foraminiferal $\delta^{18}O$ values suggest that the surface water salinity gradient was larger than 1 ä during the last glacial interval.