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PI/PD Name: John W King

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race:
(Select one or more)
☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or Other Pacific Islander
☒ White

Disability Status:
(Select one or more)
☐ Hearing Impairment
☐ Visual Impairment
☐ Mobility/Orthopedic Impairment
☐ Other
☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

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PI/PD Name: Michael Lewis

Gender: ☐ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☐ Not Hispanic or Latino

Race:
(Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White

Disability Status:
(Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

Citizenship: (Choose one) ☐ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

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PI/PD Name: Kathryn Moran

Gender: ☐ Male ☒ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race:
(Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status:
(Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

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PI/PD Name: David L Dettman

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

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PI/PD Name: Alison J Smith

Gender: ☐ Male ☒ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race:
(Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status:
(Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

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PI/PD Name: David K Rea

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race:
(Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status:
(Select one or more)
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- ☐ Visual Impairment
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- ☐ Other
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List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 03-041 **NSF 03-041**	FOR NSF USE ONLY
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) **ATM - PALEOCLIMATE PROGRAM**	NSF PROPOSAL NUMBER **0354762**

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				796475382	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY?
056000522	☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE **University of Rhode Island**	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE **University of Rhode Island** **70 Lower College Road** **Kingston, RI. 02881**
AWARDEE ORGANIZATION CODE (IF KNOWN) **0034140000**	
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE	ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE
PERFORMING ORGANIZATION CODE (IF KNOWN)	

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS
☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **"COLLABORATIVE RESEARCH: Understanding Sensitivity of Great Lakes Water Levels to Climatic Forcing: Closed Lake Status 8.4-6.8KA, 9400-7700 CAL BP"**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 359,772	36 months	12/01/03	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

- ☐ BEGINNING INVESTIGATOR (GPG I.A)
- ☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
- ☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.B, II.C.1.d)
- ☐ HISTORIC PLACES (GPG II.C.2.j)
- ☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
- ☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date ________
- ☐ HUMAN SUBJECTS (GPG II.D.6) Exemption Subsection ______ or IRB App. Date ______
- ☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j) ________
- ☒ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.E.1)

PI/PD DEPARTMENT **Graduate School of Oceanography**	PI/PD POSTAL ADDRESS **Narragansett Bay Campus** **South Ferry Road** **Narragansett, RI 028821197** **United States**
PI/PD FAX NUMBER **401-874-6811**	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **John W King**	PhD	1983	401-874-6594	jking@gsosun1.gso.uri.edu
CO-PI/PD **Michael Lewis**	PhD	1967	401-874-6182	jking@gsosun1.gso.uri.edu
CO-PI/PD **Kathryn Moran**	Ph.D	1995	401-874-6194	kate.moran@uri.edu
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grant Proposal Guide (GPG), NSF 03-041. Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

In addition, if the applicant institution employs more than fifty persons, the authorized official of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of Grant Policy Manual Section 510; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Appendix C of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Appendix D of the Grant Proposal Guide.

Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

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(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.

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AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Mary R Costa**	**Electronic Signature**	**Sep 22 2003 4:13PM**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
401-874-5138	**mcosta@uri.edu**	**401-874-4272**

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 03-041	FOR NSF USE ONLY
NSF 03-041	NSF PROPOSAL NUMBER
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) ATM - PALEOCLIMATE PROGRAM	0355217

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				806345617	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)
866004791	☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE
University of Arizona	University of Arizona 601 Administration Building Tucson, AZ. 85721
AWARDEE ORGANIZATION CODE (IF KNOWN) 0010835000	
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE	ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE
PERFORMING ORGANIZATION CODE (IF KNOWN)	

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS
☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Collaborative Research: Understanding Sensitivity of Great Lakes Water Levels to Climatic Forcing: Closed Lake Status 8.4-6.8KA \(9400-7700 CAL\)**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 24,874	36 months	12/01/03	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.A)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.B, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date ________
☐ HUMAN SUBJECTS (GPG II.D.6)
Exemption Subsection ________ or IRB App. Date ________
☒ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
CA
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.E.1)

PI/PD DEPARTMENT	PI/PD POSTAL ADDRESS
Department of Geosciences	Gould-Simpson Building, Room 208 Tucson, AZ 85721 United States
PI/PD FAX NUMBER 520-621-2672	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME David L Dettman	Ph.D.	1994	520-621-4618	dettman@geo.arizona.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grant Proposal Guide (GPG), NSF 03-041. Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

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(If answer "yes", please provide explanation.)

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AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Julia H Wood**	**Electronic Signature**	**Sep 26 2003 11:41AM**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
520-626-6127	**jhwood@email.arizona.edu**	**520-626-4130**

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 03-041	FOR NSF USE ONLY
NSF 03-041	NSF PROPOSAL NUMBER
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) ATM - PALEOCLIMATE PROGRAM	0354723

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				04-107-1101	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS ☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)
316402079		

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE
Kent State University	Kent State University P.O. Box 5190 Kent, OH. 442420001
AWARDEE ORGANIZATION CODE (IF KNOWN) 0030510000	
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE	ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE
PERFORMING ORGANIZATION CODE (IF KNOWN)	

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions) ☐ SMALL BUSINESS ☐ FOR-PROFIT ORGANIZATION ☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINESS ☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **COLLABORATIVE RESEARCH: Understanding Sensitivity of Great Lakes Water Levels to Climatic Forcing: Closed Lake Status 8.4-6.8 KA, 9400-7700 CAL**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 35,510	36 months	12/01/03	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

- ☐ BEGINNING INVESTIGATOR (GPG I.A)
- ☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
- ☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.B, II.C.1.d)
- ☐ HISTORIC PLACES (GPG II.C.2.j)
- ☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
- ☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date ________
- ☐ HUMAN SUBJECTS (GPG II.D.6) Exemption Subsection ______ or IRB App. Date ________
- ☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j) ________
- ☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.E.1)

PI/PD DEPARTMENT	PI/PD POSTAL ADDRESS
Department of Geology	Kent State University Geology Department PO Box 5190 Kent, OH 442420001 United States
PI/PD FAX NUMBER 330-672-7949	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME Alison J Smith	Ph.D.	1991	330-672-3709	asmith@geology.kent.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

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Drug Free Work Place Certification

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(If answer "yes", please provide explanation.)

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AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Charlee M Heimlich**	**Electronic Signature**	**Sep 22 2003 2:06PM**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
330-672-2070	**charlee@rags.kent.edu**	**330-672-7991**

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 03-041 **NSF 03-041**	**FOR NSF USE ONLY**
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) **ATM - PALEOCLIMATE PROGRAM**	**NSF PROPOSAL NUMBER** **0355162**

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				073133571	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY?
386006309	☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE **University of Michigan Ann Arbor**	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE **University of Michigan Ann Arbor** **3003 S State St. RM 1062** **Ann Arbor, MI. 481091274**
AWARDEE ORGANIZATION CODE (IF KNOWN) **0023259000**	
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE	ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE
PERFORMING ORGANIZATION CODE (IF KNOWN)	

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions) ☐ SMALL BUSINESS ☐ FOR-PROFIT ORGANIZATION ☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINESS ☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Collaborative research: Understanding sensitivity of Great Lakes water levels to climatic forcing: Closed lake status 8.4-6.8 KA, 9400-7700 CAL**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 124,437	36 months	12/01/03	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

- ☐ BEGINNING INVESTIGATOR (GPG I.A)
- ☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
- ☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.B, II.C.1.d)
- ☐ HISTORIC PLACES (GPG II.C.2.j)
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- ☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date ________
- ☐ HUMAN SUBJECTS (GPG II.D.6) Exemption Subsection ______ or IRB App. Date ________
- ☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j) ________
- ☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.E.1)

PI/PD DEPARTMENT **Department of Geological Sciences**	PI/PD POSTAL ADDRESS **425 E. University St.** **2534 C.C. Little Bldg.** **Ann Arbor, MI 481091063** **United States**
PI/PD FAX NUMBER **734-763-4690**	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **David K Rea**	**PhD**	**1974**	**734-936-0521**	**davidrea@umich.edu**
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

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AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Marvin Parnes**	**Electronic Signature**	**Sep 25 2003 2:24PM**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
734-936-3933	**mgparnes@umich.edu**	**734-764-8510**

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

Project Summary

Broader Impacts: The purpose of this proposal is to understand the relationship between climate change and water level in the Great Lakes. Approximately 40 million people inhabit the US and Canadian sectors of the Great lakes basin, and associated services, industries and infrastructure are vital components of both the US and Canadian economies. In addition, the Great Lakes are critical and sensitive ecosystems. Lake level changes resulting from projected global warming scenarios are likely to have significant socio-economic and environmental impacts. The information developed by this project will help guide future national policy decisions to ameliorate the societal and environmental effects of lower water levels.

Intellectual Merit: Previous reconstructions of late glacial and post-glacial lake phases in the Great Lakes have attributed major changes in lake levels to non-climatic processes (e.g. isostatic rebound and shifts in outlet elevation). New findings of early-middle Holocene lake closure events that could only have been forced by abrupt periods of severe dry climate contrast with relatively small changes in lake levels recorded within the last two centuries. Knowledge of past occurrences of high-amplitude rapid hydrological change is relevant as some scenarios of future climate driven by global warming, suggest lake-level reductions below presently-known variability may be possible in the watershed of the Great Lakes.

We hypothesize that lake levels were driven tens of meters below their outlets after 9000 cal BP (8 ka) by the combined effects of enhanced southward incursions of dry Arctic air during late deglaciation in Hudson Bay and the intensification of eastward flows of warm-dry Pacific air. The latter effect was associated with shifting atmospheric circulation about 8200 cal BP that is manifested for example in the eastward expansion of prairie vegetation in the latitudes of southern Lake Michigan and Lake Erie. This effect is thought to have delayed recovery of lakes Michigan and Huron from closed status until about 7800 cal BP (7 ka). These closed-lake events afford a useful example of past high-amplitude climate-hydrology variation because the hydrology of the Great Lakes basin had already entered its present nonglacial state.

We propose a three-year study focused on a target interval of 9400-7700 cal BP (8.4-6.8 ka). The study has three components: **1. Corroborate and test Great-Lake closed lowstands.** Sediment cores and seismic profiles available from previous studies in the Great Lakes will be used to corroborate past altitudes of water surfaces, and to ensure that lake water sources in the modeled periods were mainly a result of local hydrological processes, as at present. Limited new seismic surveys and coring will be undertaken using NOAA's vessels. These records will be supplemented by dendroclimatological studies of fossil wood from submerged *in situ* tree stumps**. 2. Evaluate paleoclimate change using multi-proxy data from small lakes in the Great Lakes watershed.** Fieldwork is proposed to survey and sample sediments in selected small lakes distributed around the periphery of the Great Lakes drainage basin to determine past atmospheric conditions and their gradients across the Great Lakes basin. Laboratory studies will identify the targeted time interval in cores using paleomagnetic and AMS ^{14}C methods. Lake sediments will be analyzed using paleoecological transfer functions and isotopic geochemical methods to derive proxy records of changes in atmospheric and hydrological conditions associated with the oscillations of the Great Lakes water levels **3. Reconstruct paleogeography and model the paleoclimate-hydrologic relationship of the Great Lakes.** Data generated in (1) and (2) above will constrain modeling of the climate-lake hydrology relationship using both an operational hydrological process model (NOAA) and an isotopic hydrological model (U Michigan) for the Great Lakes. Both will be modified for paleogeographic conditions in the targeted time interval. These approaches will determine hydrological sensitivity of the lake system to abrupt high-amplitude climate change.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

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TABLE OF CONTENTS

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TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

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TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

Appendix Items:

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1. COLLABORATIVE STATEMENT AND TEAM OF INVESTIGATORS

This is a collaborative research project with one PI, 5 co-PIs, and 7 collaborators, comprising overall 7 U.S. and 6 Canadian participants. This international team has extensive experience working in the Great Lakes, and smaller lakes within the Great Lakes watershed. The need for a multidisciplinary and multi-institutional approach is described in this proposal.

INVESTIGATOR	AFFILIATION	EXPERTISE
John King, PI	U. Rhode Island	Paleomagnetics, palynology, geochemistry, paleoclimate
Mike Lewis, Co-PI	U. Rhode Island	Great Lakes geology, seismo-stratigraphy, paleolimnology, paleoclimate
Kathryn Moran, Co-PI	U. Rhode Island	Sediment physical properties, geomechanics
Dave Rea, Co-PI	U. Michigan	Sedimentology, Great Lakes geology
Dave Dettman, Co-PI	U. Arizona	Carbonate stable isotopes
Alison Smith, Co-PI	Kent State U.	Paleontology, ostracodes
U.S. Collaborator:		
Tom Croley	GLERL, NOAA	Meteorology and hydrology, large basin (Great Lakes) runoff modeling
Canadian Collaborators:		
Steve Blasco	Geol. Survey Canada	Huron-Georgian Bay paleo-lake levels, Great Lakes geology
John Coakley	Environment Canada	Lake Erie paleo-lake levels, Great Lakes geology
Tom Edwards	U . Waterloo	Cellulose stable isotopes, paleoclimatology
Kathleen Laird	Queens U.	Diatoms; diatom transfer functions
John McAndrews	U. Toronto	Palynology, pollen transfer functions
Francine McCarthy	Brock U.	Palynology; thecamoebians

Institutions	**Year 1**	**Year 2**	**Year 3**	**Total**
University of Rhode Island	$104,828	$157,106	$97,838	$359,772
University of Arizona	$14,339	$10,535	$0	$24,874
Kent State University	$11,609	$11,881	$12,020	$35,510
University of Michigan-Ann Arbor	$70,569	$53,868	$ 0	$124,437
Totals	**$201,345**	**$233,390**	**$109,858**	**$544,593**

Note that $212,500 in leveraged funds are available for this project (reference URI Budget justification).

2. RESULTS FROM PRIOR NSF SUPPORT

King has received recent NSF funding for work on Lakes Baikal, Tanganyika, Malawi, and Bosumtwi. He also has been involved in USGS and Canadian projects on Lakes Michigan and Winnipeg that found evidence of low lake levels in the early-mid Holocene. **Dettman**'s NSF-funded research has focused on the reconstruction of the oxygen isotope ratio of ancient freshwater systems. He has continued this line of research in NSF-funded projects on the uplift of the Tibetan Platea (working in Nepal and China) and on the pre-dam hydrology and ecology of the Colorado River Delta. **Smith** has received recent NSF funding for work on ground water-surface water interactions in lakes of the Northern Great Plains, for calibration of isotopic signatures in common North American ostracode species with isotopic signatures in natural water, and for Holocene scale lake level history in the northern Great Lakes. **Rea** has had two NSF grants to study lithostratigraphy, seismic stratigraphy, lake level history, isotope geochemistry, and paleoclimate history in Lakes Michigan and Huron.

Relevant publications for King, Dettman, Smith, and Rea are summarized in their CVs.

3. ADVANCEMENT OF KNOWLEDGE AND UNDERSTANDING

The watershed of the Great Lakes lies between the Hudson Bay and Gulf of Mexico watersheds of North America, and drains to the North Atlantic Ocean via the St Lawrence River. Approximately one-third of its 770,000 km^2 area is the water surface of the 5 Great Lakes (Fig. 1). The climate and net water supply is influenced by the frequency of occurrence of the Arctic, Pacific, and Maritime Tropical air masses over the watershed (Fig. 2). The moist Maritime

Tropical air mass is the main source of precipitation. All three air masses overlap the watershed, and slight variations in long-term atmospheric dynamics can induce variations in the degree of overlap with resulting changes in climate and moisture supply *(1,2*). For the last century, fluctuations in moisture supply have been modest, resulting in an overall range of 2 m in annual water levels *(3).* Global warming scenarios project future temperature increases and basin runoff decreases that could result in reductions of outflow river discharge and drops in lake level ranging from 0.23 m to 2.48 m *(4).* The more extreme projections are beyond the limit of natural variability *(5).* This fact combined with the high level of dependence of aquatic ecosystems and economic and other societal interests on future water levels makes knowledge of the sensitivity of the lakes to climate change an important issue.

The Great Lakes basins are generally thought to be incrementally eroded depressions in relatively softer zones in the underlying Paleozoic sedimentary rock, and in weaker structural zones of the adjoining Precambrian metamorphic Canadian Shield rocks *(6*) during glaciations of the last two million years. The latest Laurentide Ice sheet reached a maximum position about 18 to 21 ka BP in the northern United States. After 14 ka proglacial lakes in front of the northward-retreating ice margin overflowed the continental drainage divide to the south. Punctuated by intervals of readvance, the northward retreat of Laurentide ice and proglacial lakes finally uncovered the entire watershed before 8 ka. Major ice sheet drainage subsequently bypassed the Great Lakes via the Ottawa and St. Lawrence rivers to the Atlantic Ocean (Fig. 3). During deglaciation a complex series of lakes formed as a consequence of the interaction of oscillatory ice retreat and advance with topography. Water surfaces fluctuated as lower outlets through previously ice covered lowlands were opened and closed. Lake surfaces also rose as ice sheet retreat allowed hydrologic connections with upstream Lake Agassiz discharge, and/or with enhanced ice sheet meltwater discharge. Throughout this period, lake elevations also changed as outflow channels were eroded and downcut. Relative water levels were also progressively altered as the basins were tilted up to the north-northeast due to glacio-isostatic rebound. This differential rebound affected lakes by reducing water depths in the north while increasing depths in the south. For the northern Great Lakes differential rebound caused complete diversion of discharge from a northern outlet to southern outlets about 5 ka *(7-12).* Only in Lake Michigan was an interpretation made, based on study of ostracode fossils, that climate had affected the limnology and possibly forced this lake into hydrologic closure about 7000 BP *(8,13).*

Apart from the above interpretation for Lake Michigan, the traditional understanding of the evolution of the Great Lakes generally implied 3 assumptions: (1) the water balance was always positive so lake levels were mainly determined by the elevation of their outlets; (2) evidence of water levels lower than present could be explained by relative lake level change forced by differential crustal rebound; and (3) climatic change over the basin was modest and resulted only in level modulation, similar to or only slightly greater than present conditions, and major episodes of dry climate and hydrologic closure had not occurred.

The above view of the Great Lakes being relatively unaffected by high-amplitude climate change began to be questioned by us when we discovered that the south basin of Lake Winnipeg (Fig. 4) had dried up between 7.5 ka and 4 ka *(14).* Our questions were supported by existing and emerging evidence in the Huron basin. Recent seismic reflection data and sediment cores in northern Lake Huron had revealed a sediment architecture that implied lowstands in the lake history, the last of these being a strong event dated 7.9-7.5 ka (*15-17)* (Fig. 5). Subsequent studies on the sill at the entrance to Georgian Bay discovered 6 submerged tree stumps with ^{14}C ages between 7230 and 8560 BP in water depths ranging down to 43 m *(18*). A beach deposit, recognized at 53 m depth, together with pollen evidence of shallow-water in a deepwater core suggested that lake level at 7.5 ka was ~ 35 m below the basin outlet at North Bay *(19)*.

Our re-assessment of Great Lake levels included development of a new synthesis of glacio-isostatic rebound using an empirical model to describe vertical earth movement with time *(20)*. The parameters of the model were controlled by the upwarped glacial lake shorelines throughout the Great Lakes. With this model we were able to restore indicators of former water levels of any age to their original elevation in the Huron basin. The indicator data *(21,22)* consisted mostly of isolation basins *(11,23),* but also the evidence of dated submerged tree stumps *(18)*. As a result of the restoration, indicators of similar age would cluster at similar positions in the field of a plot of original elevation versus age (Fig. 6). A lake level curve (heavy blue line) was estimated through the restored indicator data. Episodes of low lake level agreed remarkably well with the ages of the seismically determined lowstands *(15).* The Huron basin lowstand in the target interval is tied to the submerged beach of Blasco *(19)* and to a lithological unconformity named after Stanley by Hough *(24).* A similar lowstand is seen in the Michigan basin *(8,25-27).*

Model estimates of the elevation history of potential Huron overflow outlets were added (Fig. 6). The trajectory of the North Bay outlet passes 40-50 m above the inferred water surface at 7.9-7.5 ka (8900-8400 cal BP). A 40-50m depression of the lake below its outlet can only be attributed to a severe dry climate. This result contrasts with an open overflowing lake preceding and following the episode of closed lake status, and implies the impact of a high-amplitude climate change.

A hypothesis for the early severe dry climate impact from 7.9 ka to 7.5 ka (8900-8400 cal BP) is suggested by a correlative episode of more negative $\delta^{18}O$ values of the sediments of Deep Lake, MN *(28)* (Figs. 4,7). It was noted that the Laurentide ice in Hudson Bay was downwasting rapidly during this period, and Yu and Wright *(29)* suggested that this reduction allowed for more frequent outbreaks of Arctic air. The frequent cold air cover would cause southern air masses to rise with the effect that moisture would have been condensed at lower temperatures and the resulting precipitation would carry a more negative isotopic signal. Because Arctic air lacks moisture *(30,31),* we suggest that the outbreaks were extensive enough to cause a net reduction in water supply and an increase in evaporation leading to drawdown and closed lake status. Thus, the early part of the closure, until 7.5 ka (8400 cal BP) is thought to reflect a cold dry climate. We attribute the latter part of the lowstand to an increase in warm, dry westerly air flow (Pacific air in Fig. 2). An increase in warm, dry westerly airflows at this time is also consistent with reorganization of atmospheric circulation observed in the Elk Lake, MN record. This change is attributed to rapid change in the relative surface areas of ice, land and ocean *(2),* and with the 8.2 cal BP cool event recorded in Greenland ice cores *(38)* attributed to final drainage of glacial lakes Agassiz and Ojibway *(39,40).* This increase was suggested by Forester et al. *(13)* based on ostracode evidence of inferred low water (Fig. 8) in Lake Michigan that peaked around 8200 cal BP (7.4 ka). An enhanced warm, dry climate is also shown by reconstructed mean annual temperature and precipitation from pollen data *(32)* which suggest increased aridity in the southern Lake Michigan area peaking in the 8400-7800 cal BP interval (Fig. 9). This suggestion is consistent with an eastward expansion of prairie toward the southern Great Lakes basin *(33-37)* (Fig. 4, prairie peninsula). The occurrence of very negative $\delta^{18}O$ values in Huron and Michigan (Fig. 10) during the target interval presents a challenge for our hypotheses of climate and closed lake status. High rates of evaporation implied by the postulated dry climate would be expected to shift isotope ratios to more positive values. The ^{18}O depleted values are more characteristic of meltwater *(41-43a).* Alternate explanations include glacial groundwater reflux, backflow from proglacial lake discharge down the Ottawa River, the influence of cold Arctic air on precipitation, or melt from residual ice masses. Sources of the water with very negative $\delta^{18}O$ values will be sought by establishing spatial gradients of isotopic composition within the Great Lakes and between small atmosphere-charged lakes around the basin for the target time interval.

Overall, we propose to quantify the high-amplitude paleoclimate changes and their impacts on the hydrology and lake levels of the Great Lakes basin, with particular reference to the Huron-Michigan portion of the drainage system, for the time interval of 9400 to 7700 cal BP. Our purpose will be accomplished through: (1) study of archived cores and seismic profiles and new cores from southern Lake Huron to corroborate the inferred closed lake lowstands (Fig. 11); (2) use of multi-proxy paleoecological and geochemical methods to study sediments from small headwater lakes in order to obtain quantitative estimates of former mean climate parameters; and (3) use of geographic information system methods to reconstruct the paleogeography for the target interval, and paleohydrological modeling to estimate the sensitivity of the Great Lakes hydrology and levels to high-amplitude climate change.

The knowledge and understanding of the Great Lakes we plan to generate from the proposed research consists of: (1) documentation of a widespread episode of closed lakes, which will add a new chapter to the history of the Great Lakes; (2) multi-proxy quantification of climate changes in the Great Lakes basin and comparison with known paleoclimatic events, (e.g. the final disintegration of the Laurentide ice sheet, the 8200 cal BP cool event, and vegetation changes (e.g. expansion of the prairie peninsula)); (3) an understanding of the climate-hydrology relationship, and derivation of the sensitivity of lake levels to high-amplitude climate change through numerical modeling; and (4) an explanation for depleted isotopic composition of Huron basin waters during the target interval.

4. SOCIETAL BENEFITS AND BROADER IMPACTS

Findings of this project will:

(1) *Increase general awareness about the sensitivity of water levels to climate change and the utility of understanding impacts of paleoclimate change*. Corroboration of our hypothesis of a past high-amplitude climate change that drove lake levels below their outlet channels is a new aspect of the geological history of the Great Lakes, and will be a surprising discovery that should heighten societal interest in climate change. The results of the project will contribute additional perspective and confidence for advice on policy or decision-making by government programs on climate change as reviewed by a recent report for the International Joint Commission *(130)*.

(2) *Benefit evaluation of global warming impacts on future water balance and lake levels*. While important insight into lake response under changed climates has been obtained by atmospheric circulation experiments and climate transposition studies *(3),* no one method of assessment is completely adequate *(4)*. At present, assessment of future projected lower levels, some of which are lower than natural variability *(5),* must be based on extrapolation of historically-recorded climate-hydrologic variation (mostly sub-meter) from time-averaged levels. By quantifying the inferred high-amplitude paleoclimate changes, and modeling the severe hydrological response to them, the sensitivity of water levels to high-amplitude climate change can be reconstructed. Future estimated Great Lakes levels would be an interpolation between known modest variability and past examples of extreme variability. Interpolation is usually less risky than extrapolation beyond known conditions.

Projected changes are likely to seriously compromise societal interests of commercial shipping, recreational boating, shore infrastructure, hydro-electric power production, and nearshore habitat *(4, 43a),* as well as drinking water supply and quality. A projected 1-m lake lowering would cause a permanent ~15% loss of cargo capacity. This loss is estimated at billions/year under the present low-water conditions (National Geographic, September 2002; Toronto Globe and Mail, July 23, 2001). Higher amplitude reductions in lake levels would cause major economic disruptions in Canada and the U.S.

(3) Contribute analogs for evaluating future scenarios of Great Lakes oxygen deficiencies and ecosystem quality under global warming. Significant changes to the ecosystem in a warmer climate are projected as well. Changes in ice cover and habitat temperatures, decreased turnover that could increase anoxia in bottom waters, drying of wetlands, and northward displacement of fishery habitat are all foreseen *(44-47)*. Enhanced dredging resulting from future lake-level declines is a threat to environmental quality as contaminated lake bottom sediment is disturbed.

(4) Contribute to evaluation of regional climate models. One such regional model is the Canadian Regional Climate Model for eastern North America that was evaluated by simulating the observed seasonal evolution of surface temperature and ice cover in the Great Lakes *(49)*. This and similar models could be further tested when the geological observations of former lake levels are compared with the hydrological outputs of paleoclimates and paleogeography of the Great Lakes as explored in this project.

5. PROJECT OVERVIEW

This project is a three-year, multidisciplinary, multi-institutional laboratory program with a modest but highly relevant field component. It is designed to integrate knowledge bases of Great Lakes level oscillations and abrupt paleoclimate changes for input to paleohydrological response modeling. We will focus primarily on the century-scale environmental history of the central Great Lakes sector in the 9400-7700 cal yr BP (8.4-6.8 ka) time interval. The project has three major objectives:

(1) Corroborate and test Great-Lake closed lowstands. Available sediment cores and seismic profiles (Fig. 11) from previous studies will be used to corroborate past altitudes of water surfaces (large lake response to climate change), and to ensure that lake water sources in the modeled periods were mainly a result of local hydrological processes, as at present. Limited new seismic surveys and new coring will be undertaken in southern Lake Huron and Lake Erie.

(2) Evaluate paleoclimate change using multi-proxy data from small lakes in the Great Lakes watershed. Fieldwork is proposed to survey and sample sediments in selected small lakes distributed around the periphery of the Great Lakes drainage basin to determine past atmospheric conditions and their gradients across the Great Lakes basin. Laboratory studies will identify the targeted time interval in cores selected for study, both from large and small lakes using paleomagnetic and AMS ^{14}C methods. Paleoecological transfer functions and isotopic geochemical methods will be used to derive proxy records of changes in atmospheric and hydrological conditions. These records will be supplemented by dendroclimatological studies of fossil wood from submerged *in situ* tree stumps.

3) Reconstruct paleogeography and model the paleoclimate-hydrologic relationship of the Great Lakes. Data generated in 1) and 2) above will constrain modeling of the climate-lake hydrology relationship using both an operational hydrological process model (NOAA) and an isotopic hydrological model (U Michigan) for the Great Lakes. Both will be modified for paleo-geographic conditions in the targeted time interval. These approaches will determine hydrological sensitivity of the lake system to abrupt high-amplitude climate change.

6. PROPOSED WORK

6.1 Corroborate and test Great-Lake closed lowstands: The closed lowstands recognized to date are based on data in the southern Michigan and northern Huron-Georgian Bay basins (e.g. Fig. 6). These lowstands imply that sub-basins in southern Lake Huron were also closed, as reconstructed in Fig. 12. Profiles and cores will be recovered from the Goderich sub-basin (Fig. 12) to test this hypothesis using a NOAA ship. Previous work has shown the sub-basin contains a thick section (>10 m) of Holocene sediments with evidence of a dry zone *(50,51)*.

Core property information for the target period in northern Michigan-Huron-Georgian Bay will be expanded beyond the existing core 37 through analysis of a network of 10 cores (Fig. 11). Very negative $\delta^{18}O$ values of ostracode valves correlated to 7.9-7.5 ka in core 37 (Fig. 10) have been interpreted as meltwater flow from the Laurentide Ice sheet through the upper Great Lakes basins *(41,52,43)*. The interpretation of late eastward-flowing meltwater at 7.9-7.5 ka has been questioned because of its unusually young age. Meltwater discharge was thought to be bypassing the Great Lakes basin via proglacial Lake Ojibway according to regional deglacial history *(53,11,10)* (Fig. 3). Proposed alternate sources of the isotopically light lake water will be determined by comparing spatial patterns and gradients of ostracode $\delta^{18}O$ ratios in the 10-core network (Fig. 11) and between small atmosphere-charged lakes around the Great Lakes basin (Fig. 1) for the target study period. Alternate explanations *(54)* for the ^{18}O-depleted lakewater might include: 1) inflow by backflooding of Ojibway meltwater drainage from the Ottawa River; 2) reflux of glacial groundwater into lake lowstands; 3) air mass circulation changes bringing more frequent incursions of Arctic air, and 4) glacial meltwater from an as yet unidentified route. The isotope gradients observed in Great Lakes cores and isotope results from small lake cores will be used to test the competing hypotheses.

We will target the lowstand in eastern Lake Erie, mapping its geomorphic expression from seismic profiles, and searching for AMS^{14}C-dateable fossils in cores from nearshore sediments to determine the age of a postulated Erie closed lake phase *(55)* (Fig. 13).

In Lake Ontario, an early to middle Holocene transition to increasingly ponded sediment architecture has been noted by Hutchinson et al. *(56)*. The transition probably implies onset of windier conditions. We aim to determine the age of the transition for comparison with other evidence of aeolian intensification in North America about 8200 cal BP *(38,1)*. Cores for this purpose have been provided through the use of Environment Canada shiptime.

6.2 Evaluate paleoclimate change using multi-proxy data from small lakes in the Great Lakes watershed: Water supply to small lakes with small catchment areas in headwater settings is most likely to be dominated by atmospheric precipitation (*57*). Sediments within these atmosphere-charged lakes are therefore likely to be optimal archives for recording variations in paleoclimate *(58)*. We plan to core selected small lakes around the perimeter of the large Great Lakes drainage basin to avoid lake-effect precipitation from the Great Lakes themselves as much as possible, locations in Fig. 1. The present state of knowledge about these lakes is summarized in Table 1. Optimal coring locations in each basin will be identified following acoustic profiling (Knudsen 28 kHz or Chirp sonar). Either two complete cores with offset section breaks will be recovered using a square-rod Livingstone piston corer, or two cores will be obtained with an ETH-type piston corer. Reflections, representing unconformities, in the profiles will be analyzed from a physical property prospective (*59*), and from a seismic stratigraphic perspective for evidence of past changes in lake level. This approach was used in northern Lake Huron and northern Lake Michigan where the Light Blue reflecting sequence boundary was linked to the major lowstand at 7.9-7.5 ka *(60,61)*.

Annually laminated sediments from Lake of the Clouds *(62)* west of Superior basin will be used to test for and confirm the presence of similar climate (dominated by incursions of Arctic air) from 7.9-7.5 ka over the Superior basin as was inferred from the ^{18}O-depleted record in Deep Lake, northern Minnesota *(28,29)*. Alternate lakes northwest of Lake Superior are Cummins and Oliver ponds, which are known to contain carbonate-rich sediment from which a $\delta^{18}O$ record can be obtained *(63)*.

From the southeastern extremity of the Great Lakes, we propose to use an existing core from Seneca Lake and a new core from the annually laminated sediments of Fayetteville Green Lake (Fig. 1), known to contain carbonate fossils and sediment *(64,65)*.

Between these extremes of location, we will examine sediment records from Jack Lake *(66)* and Found Lake (annually-laminated, McAndrews data, unpublished) on the northern and eastern margins of the Great Lakes drainage basin. These sites are well-positioned to have encountered the atmospheric changes inferred for Deep Lake MN and the Great Lakes system (Figs. 2,4). Carbonate sediments are found in Seneca and Green lakes and will be sought in this region for their $\delta^{18}O$ record of precipitation change in order to better understand the O isotope record in offshore Huron basin sediments during the 7.9-7.5 ka lowstand *(41,42,52)*.

Sites on the southern margin of the Great Lakes drainage basin will be examined to document paleoclimate changes related to the Prairie Peninsula expansion ca. 8800-7400 cal BP (ca. 8-6.5 ka). These include Pretty Lake between southern Lake Michigan and Lake Erie *(67,68*), and Lake LeBoeuf south of east-central Lake Erie (Fig. 1). These lake sites are close to early to middle Holocene vegetation zone boundaries (ecotones) so their sedimentary pollen contents are expected to be sensitive to climatic variation *(69)*. Additional paleoclimate information will be available through an informal collaboration with Chad Wittkop and H.E. Wright, Jr., University of Minnesota from Derby Lake east of south-central Lake Michigan where paleoclimatic variability is inferred, and ^{18}O enrichment in carbonate suggests reduced lake-effect precipitation from a closed Lake Michigan 8.0 to 7.5 ka *(70)*.

6.3 Detailed Methods of Core and Wood Analysis

6.3.1 Chronology and sediment properties. At present, the existing eastern United States secular variation (SV) reference curves *(71)* (Fig. 14) can be used for correlation and dating with a resolution of $\pm$ 200 years. In the proposed project, a state-of-the-art cryogenic u-channel magnetometer facility at the University of Rhode Island will be used to measure remnant geomagnetic fields in about 20 existing cores from the Great Lakes (including the 11 cores sites shown in Fig. 11) and about 20 new cores from small lakes in the drainage basin (including the 8 sites shown in Fig. 1). These measurements will define secular variation of inclination and declination during the Holocene, and will establish a time scale for the cores calibrated to the SV reference curve. New AMS ^{14}C determinations of plant macrofossils or invertebrate shells corrected for hard-water effect *(72)* for both small-lake and Great Lakes sediments will be used to refine the SV reference curve chronology. This combined paleomagnetic-AMS radiocarbon approach can be applied relatively rapidly, and will provide a comprehensive accurate chronology (estimated within 100 years) of the cores by means of which the 8.4-6.8 ka target interval will be identified for detailed study. Preliminary results of this approach for Lake Ontario cores are shown in Fig. 15.

Several of the small lakes proposed for study (e.g. Lake of the Clouds, Green Lake, and Derby Lake) have annually laminated (varved) sediments. We propose to do varve chronology studies in the target interval to further refine the chronology. Brad Hubeny, a URI graduate student, has already been trained in the necessary methods *(73-76)* for this aspect of the study.

Core sediment texture, color (using digital imagery), consistency, structures and unusual inclusions, physical sediment properties, including magnetic susceptibility, bulk density, and sound velocity will be measured at 1-2 cm intervals using Geotek instrumentation These high resolution physical properties will be used to identify lowstand events In addition to stable isotopic composition, particle size, inorganic elemental geochemistry, and organic geochemical composition (Corg, C/N ratio in bulk sediment) will be measured to facilitate correlations among cores, and interpretations of change in climate and lake response.

Sediment particle size distributions are sensitive to lake level variations, and for Lake Huron lowstands are characterized by slightly coarser mean grain size, even in deepwater clays *(41).* Similar analyses, using new Coulter Counter equipment at University of Michigan under direction of D. Rea, will be obtained at cm-scale resolution as appropriate to obtain sub-century temporal resolution of variations in lake level.

6.3.2 Paleo-environmental inferences from pollen, ostracode, diatom and thecamoebian fossils. We will assemble existing and new pollen data, and derive proxy climate parameters emphasizing the target region at 8.4-6.8 ka. New pollen data will be generated at URI by King and Hubeny, and by Canadian collaborators McCarthy and McAndrews. We will reconstruct mean July and January temperatures and mean annual precipitation using pollen-climate transfer functions and response surfaces *(77-80).* Paleoclimate maps of January and July mean temperatures, as well as mean annual precipitation will be constructed and compared with other proxy data and modern climate. An aridity index will be calculated and mapped.

The Great Lakes share a common ostracode species assemblage, which consists of species tied to profundal and littoral lacustrine environments, as well as those associated with ground water discharge (*13,41,9,52*). These groups provide a source of ecological and geochemical information such as water temperature and solute changes that can be used to reconstruct paleohydrologic and ground water discharge history, and to assess paleoclimate changes affecting the supply of precipitation and seasonal temperatures *(81-85).* For example Forester, et al. *(13)* determined histories of shore proximity (Fig. 8) and solute concentration in Lake Michigan. These studies will be done at Kent State by Smith.

Different species of diatoms flourish in specific habitats. Fossil diatom assemblages are commonly used to identify changes in paleo-environment, for example, through the use of transfer functions to quantitatively reconstruct Holocene climatic fluctuations in northern Fennoscandia *(86)*, the paleo-salinity history of prairie lakes *(87-88),* and dissolved organic C history in a northern Quebec lake *(89*). Correspondence between diatom assemblages (as well as C and N) and instrumental climate records is known for European mountain lakes *(90).* For this study we will determine the species composition of diatoms through the target interval of the new cores and selected existing cores to reconstruct paleoclimate or other paleo-environmental parameters where transfer functions are applicable. These studies will be done at Queens by Laird.

Thecamoebian fossil assemblages in lacustrine sediment are being increasingly studied for information about paleo-environmental changes, for example to recognize climate effects in Georgian Bay *(91)*, and early saline conditions in the development of the large Lake Winnipeg *(92).* Thecamoebian assemblages will be tested for paleo-environmental information in the target study interval of new and selected existing cores in this study. This study will be done by McCarthy at Brock.

6.3.3 Inferences from stable isotopic composition of lacustrine carbonates. The O isotopic composition of lacustrine carbonates depends on the temperature and composition of the water in which they form *(67).* To the extent that lake water is replenished by precipitation, changes in atmospheric circulation and temperature can be detected. Carbonate materials in lake sediment can be used to constrain the $\delta^{18}O$ value of lake water through time. The methods used depend on the materials recovered from the cores. Fine-grained carbonates typically form in the late spring *(93)* and can be used to calculate water $\delta^{18}O$. Ostracode and mollusk shells can also be used to constrain the $\delta^{18}O$ of lake water based on modern calculations of the oxygen isotope fractionation - temperature relationship (94-96,52). Depending on the species available, we may be able to use their thermal preferences to limit possible temperatures or use single valve measurement of ostracode shell $\delta^{18}O$ to constrain water $\delta^{18}O$ as in Dettman et al. *(52),* and to infer sources of inflowing water or changes in atmospheric precipitation and evaporation. Carbon isotopic ratios will also be determined from the same material to give information, along with the C/N ratios on bulk organic matter, about changes in lacustrine organic productivity and provenance of sedimentary organic matter *(97).* Isotope analyses of the ostracode fauna and/ or lacustrine carbonate precipitates in the core intervals enclosing the target time period will be made at the University of Arizona stable isotope laboratory by Dettman using standard equipment and procedures for paleoenvironmental analysis (52,95).

6.3.4 Inferences from fossil tree and organic sediment cellulose isotopic investigations. Edwards (U of Waterloo) will examine the isotopic composition ($\delta^{18}O$ and $\delta^{13}C$) of the algal cellulose fraction of gyttja sediment in the small paleoclimate lakes where carbonate is unavailable following methods of Edwards and Fritz *(98-100*). Similar analyses on cellulose in wood *(101)* are proposed for early to middle Holocene submerged stumps recovered from the sill between Georgian Bay and Lake Huron *(102),* and the Olson drowned forest in southern Lake Michigan *(103).* Although some controversy did exist, it has been recently demonstrated that hydrogen and oxygen isotope ratios of tree-ring cellulose record both source water and humidity conditions *(104).* Thus the above analyses will be independent indicators of the isotopic composition of atmospheric precipitation, and will assist with the deconvolution of hydrologic and atmospheric signals in the lake-based ostracode and algal cellulose isotope records.

6.4 Reconstruct paleogeography and model the paleoclimate-hydrologic relationship of the Great Lakes: Thirty-arc second digital elevation models of the topography and bathymetry of the Great Lakes basin will be reconstructed at about 200-year intervals through the target study interval (9400-7700 cal BP) *(105).* Reconstructions will be done by a Arc Info geographic information system at URI by removing the effects of glacial rebound, and where appropriate, lake sediment accumulation. These reconstructions will provide information on basin area, lake area, lake volume, drainage routing, and water depth for input to hydrological modeling and paleolimnological interpretation.

The paleohydrology of the Great Lakes system (central sector) will be explored using two models. The first is a basin box model previously employed to characterize water oxygen isotopic composition and meltwater discharge through the entire Great Lakes basin for estimation of freshwater output to the North Atlantic Ocean during the Younger Dryas (11-10 ka) interval *(43).* This model will enable us to constrain water transfers within the Great Lakes system according to the geological observations and inferences of paleo-water isotopic composition. The second model, GLAHPS (Great Lakes Advanced Hydrologic Prediction System), is a more detailed and complex construction which is currently used for seasonal forecasting of lake levels. Modeling will be done by Croley and Rea at Michigan in collaboration with the other project investigators.

We will adapt the GLAHPS to conditions in the 8.4-6.8 ka period and explore possible meteorology scenarios and their resulting (modeled) hydrologic scenarios with associated lowstands in the Huron and other basins that are compatible with geologic evidence for closed lakes. NOAA built GLAHPS as a system of hydrologic process models to estimate water and energy balances, whole-lake heat storage, and lake levels (106-112). These include models for rainfall-runoff, evapotranspiration, and basin moisture storage (113,114), overlake precipitation, one-dimensional (depth) lake thermodynamics for lake surface flux, thermal structure, evaporation, and heat storage (115-118), net lake supplies, and channel routing *(119-121)*. Croley et al. *(3)* conveniently summarizes details of these models which are used in both lake-level forecasting and climate change impact simulations. These models have been used to study changed climates resulting from increased CO_2 emissions by adapting the historical meteorological record consistent with general circulation model (GCM) simulations *(122-124)*. A similar approach will be used to investigate inferred climate differences between now and 8.4-6.8 ka and to resulting hydrological impacts on Great Lakes levels. Adaptation of the models to relate isotopic composition of precipitation and inflows to that of lake water will be attempted.

This exploration will consist of a study of the sensitivity of Great Lakes to broad changes in meteorology. It will begin with simple, across-the-board, shifts in precipitation, air temperature, wind speed, humidity, and insolation, using the recent (last 50 years) daily meteorological record and model calibrations over recent hydrologic records. The shifts will be guided by the paleoclimate determinations of the project and by known insolation differences of the target study interval from the present. Our sensitivity analysis will yield results indicative of the impacts associated with changed climates. The range of shifts in meteorology to be used will be suggested by current knowledge of mid-continent paleoclimate, and possibly by GCM simulations for 8.4-6.8 ka. A variety of shifted conditions considered both separately and in combination will be employed to discern climate combinations that could have resulted in Great Lakes lowstands and their inferred isotopic composition. The project geoscientists will inspect these combinations to ascertain likelihood of compatibility with other evidence. Each shift will be applied to the entire historical meteorological record. This record will then be used to simulate 50 years of daily values of 28 hydrologic variables, including lake evaporation, basin runoff, and lake levels.

The simulated hydrology then will be compared to that obtained from the unshifted meteorology to estimate the impact of the shift with respect to present climate. Differences in simulated hydrologies before, during and after the lowstand phase within the 8.4-6.8 ka period will provide estimates of the impact of paleoclimate change within the target study interval. The magnitude and rapidity of the paleo-impacts will indicate a measure of the sensitivity of the central Great Lakes to relatively high-amplitude climate change for comparison with sensitivities derived from low-amplitude climate-lake level variability in the historical record.

7. SCHEDULE OF RESEARCH ACTIVITIES AND OUTPUTS (Fig. 16)

The project timeline is summarized in Fig. 16. Most proxy climate data acquisition will be complete in early 2005, and preliminary model results will be available. A workshop in early 2005 of all participants during the latter phase of data acquisition and middle stages of the modeling will facilitate reaching scientific consensus on the paleoclimate and climate-hydrology (lake level) sensitivity. Estimated timing for submittal of major papers is shown in Fig. 16. Validation of scientific results will be sought through presentations and discussions at selected conferences during the term of the project (Fig. 16).

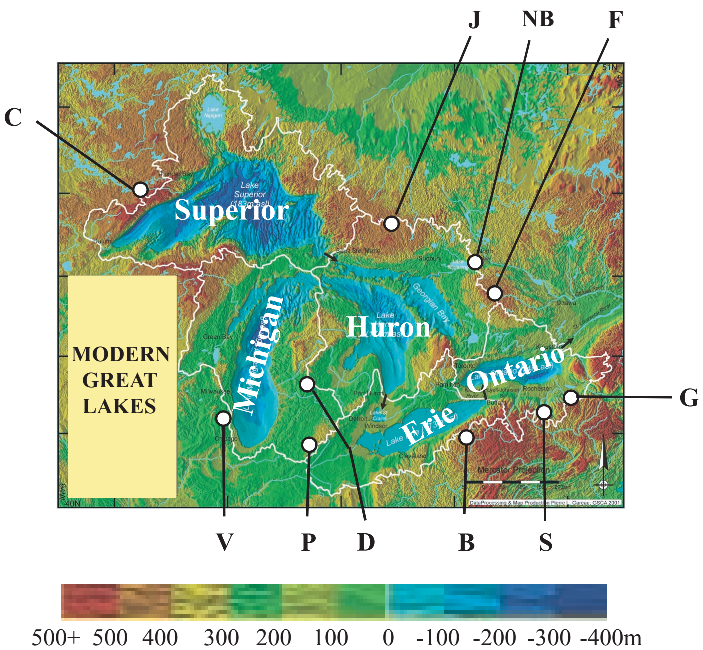
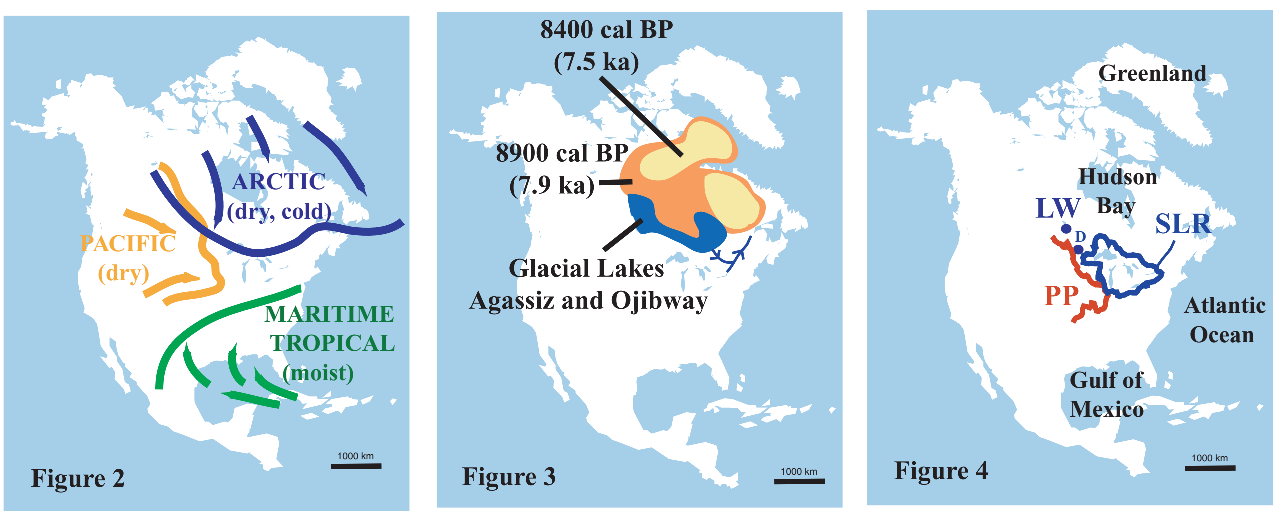


Figure 1. Modern Great Lakes (blue areas labeled with lake name). The Great Lakes drainage basin is outlined in white on this 30-arc second shaded-relief digital elevation model coloured in 100-m intervals of topography and bathymetry. Color bar below figure indicates land elevation relative to present-day sea level (reds and greens) and lake depth (blues). (Files are available to this project; a contoured printed version was published 1996 as Canadian Hydrographic Service Map 880A). Also illustrated is location of Volo Bog (V) near southern Lake Michigan, and North Bay (NB). Owing to glacial isostatic depression, the northern Great Lakes drained northeast through the North Bay outlet to Ottawa River (10-5 ka). Small lakes proposed for coring and investigation (dots not to scale) include**:** Lake of the Clouds (C), Pretty Lake (P), Lake Le Boeuf (B), Seneca Lake (S) (core already at hand), Derby Lake (D), Green Lake (G), Found Lake (F), and Jack Lake (J).



FIGURES 2-4.

Figure 2. Present-day distribution of airstreams (5-month dominance) over North America (adapted from Bryson, 1966; Bryson and Hare, 1974). **Figure 3:** Location of the Laurentide Ice sheet about 8900 cal BP (7.9 ka - orange shading) and 8400 cal BP (7.5 ka - yellow shading)(Outline from *(39)* and A. F. Dyke, pers. comm., 2002). Note that drainage from proglacial lakes Agassiz and Ojibway (blue shading) after 8 ka bypassed the Great Lakes basin, discharging via Ottawa and St. Lawrence rivers to Atlantic Ocean (blue arrows show direction of flow). **Figure 4:** Shows Great Lakes (inside blue line) and their drainage basin (blue line), outflowing St. Lawrence River (SLR), present Prairie Peninsula vegetation zone (PP), locations of Deep Lake (D) *(28)* and Lake Winnipeg (LW)(size of dots not to scale), and Hudson Bay.

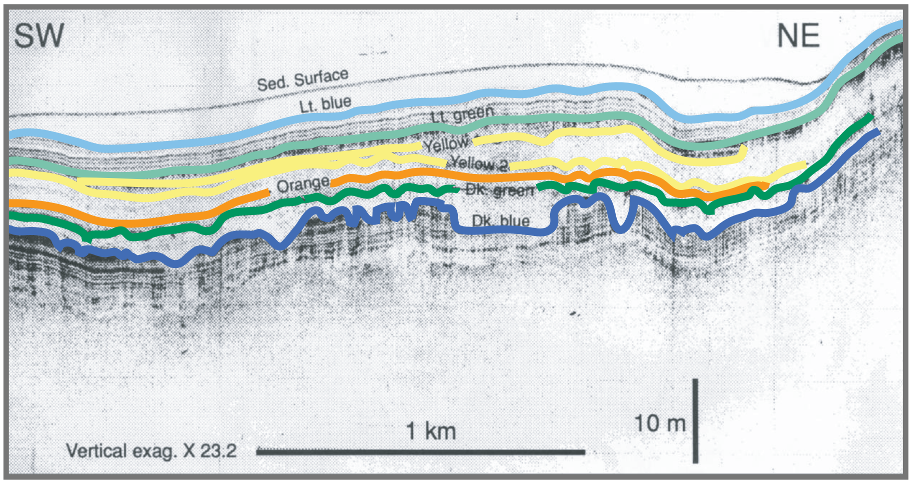


Figure 5. Seismic boomer profile (2-6 kHz) showing sediment sequence boundaries (labeled with color names) in relatively deep water in northern Lake Huron. The boundaries are conformities which can be traced to unconformities in shallower water, indicating erosion by wave activity during lowstands in the early-middle Holocene history of Lake Huron. Our target study interval (9400-7700 cal BP; 8.4-6.8 ka) includes the period of the last (Light Blue) lowstand dated 8900-8400 cal BP (7.9-7.5 ka) *(60)*.

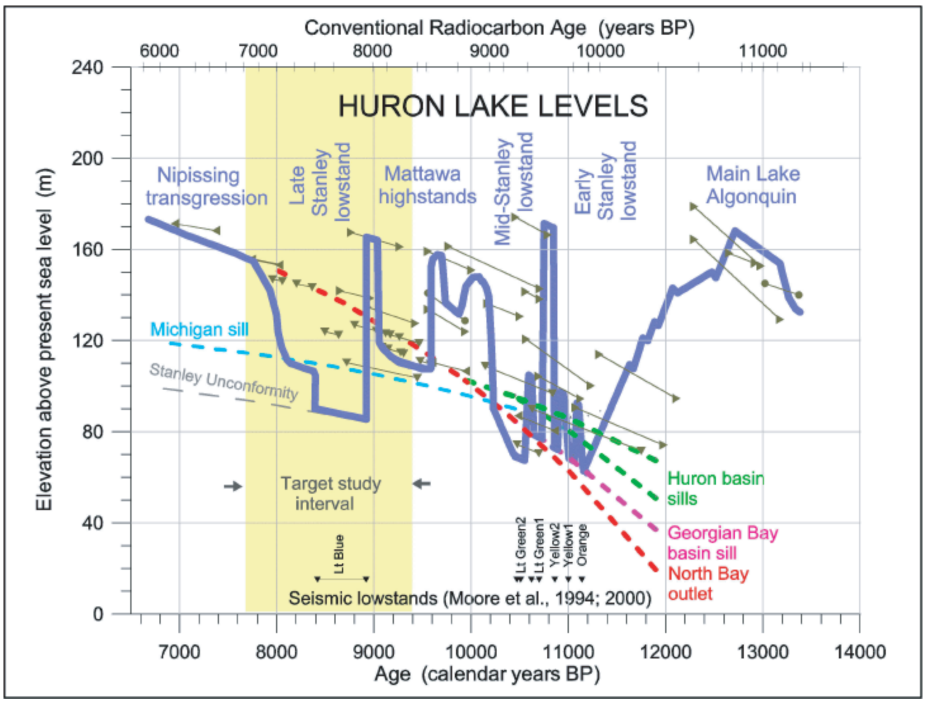


Figure 6. Paleo-lake levels (thick blue line) in the Huron basin (adapted from *(125)*). Within the target time interval of this study (9490-7700 cal BP), the water level was below the lowest possible basin overflow route (dashed red line marked North Bay outlet) from ca. 8900-7800 cal BP, indicating the lake was hydrologically closed, drawn down by a climatic shift to a drier regime with more evaporation and/ or less precipitation and runoff. In this plot of elevation vs age, radiocarbon-dated lake level indicators (olive-colored symbols and lines showing one-sigma uncertainty) and overflow outlets (colored dashed lines) have been re-constructed by removing the effects of glacial rebound, and are shown at their original altitudes. The symbols indicate the type of indicator: right-pointing triangles represent isolation basins from which the large lake has regressed; left-pointing triangles represent basins which the lake has transgressed and inundated; circle represents water level at a delta or beach; downward-pointing triangles represent in situ tree stumps requiring a lake level below their root elevations. The lake level indicators are compiled and described in *(11)* and *(9)*. Seismic lowstands are low lake levels identified by seismo-stratigraphic sequence boundaries in seismic profiles *(43,72)*. Stanley unconformity is a sedimentary erosional discontinuity in northwestern Lake Huron indicating low lake levels *(9,126),* believed to be correlative with the Flowerpot beach now submerged 53 m beneath Georgian Bay (*102*).

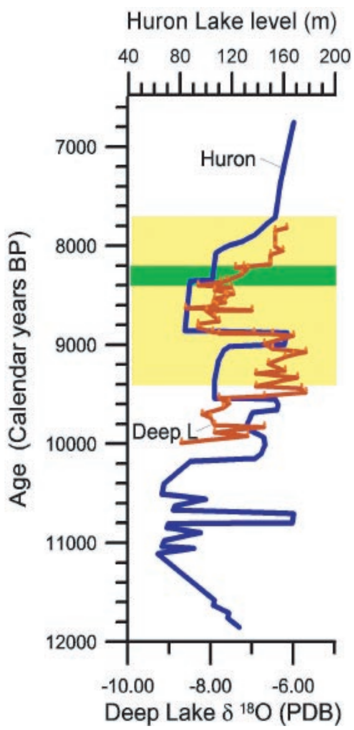


Figure 7

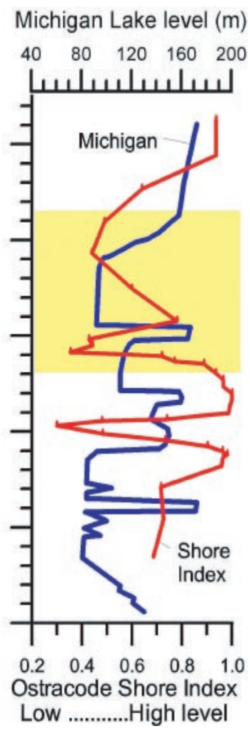


Figure 8

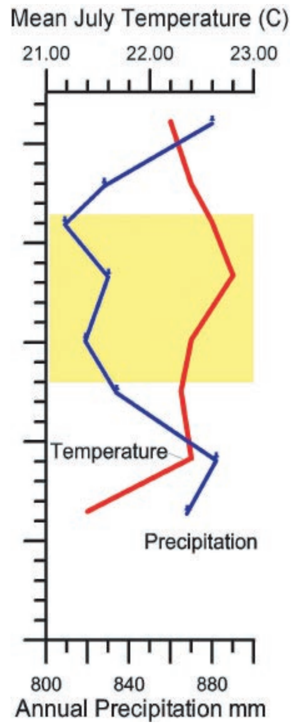


Figure 9

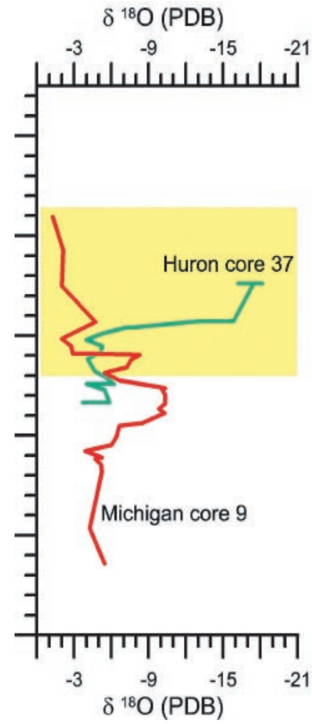


Figure 10

Figures 7-10. History of variations of lake levels and selected parameters with target study interval depicted in yellow.

Figure 7: Note correlation of lowest Huron water levels and the most negative $\delta^{18}O$ values in Deep Lake (D in Fig. 4) *(28)*. Green bar indicates similarity in timing of end lowest Huron levels, final drainage of proglacial lakes Agassiz and Ojibway to Hudwon Bay, and 8.2 cal KA Greenland cool event *(39)*. **Figure 8.** Similarity in changes of lake levels and an ostracode shore index (with lag) (adapted from *(13)*) is indicated in the Michigan basin for the target study interval (yellow). **Figure 9.** Mean July temperature and mean annual precipitation derived by transfer functions from pollen content at Volo Bog (Fig. 1) *(77, 127)* suggest increased evaporation and reduced water supply for southern Lake Michigan about 7800 cal B.P. Present values are 22.4˚C and 933 mm. **Figure 10.** $\delta^{18}O$ ratios in Huron ostracodes *(41,42,52)* and Michigan mollusks *(128,129)*. An explanation will be sought in this project for the much larger shift (about 4-fold greater) to more negative δ18O values in Huron basin compared with Michigan basin at 8900 cal BP. See Figure 11 for location of Core 9.

Seismic Profiles **Cores**

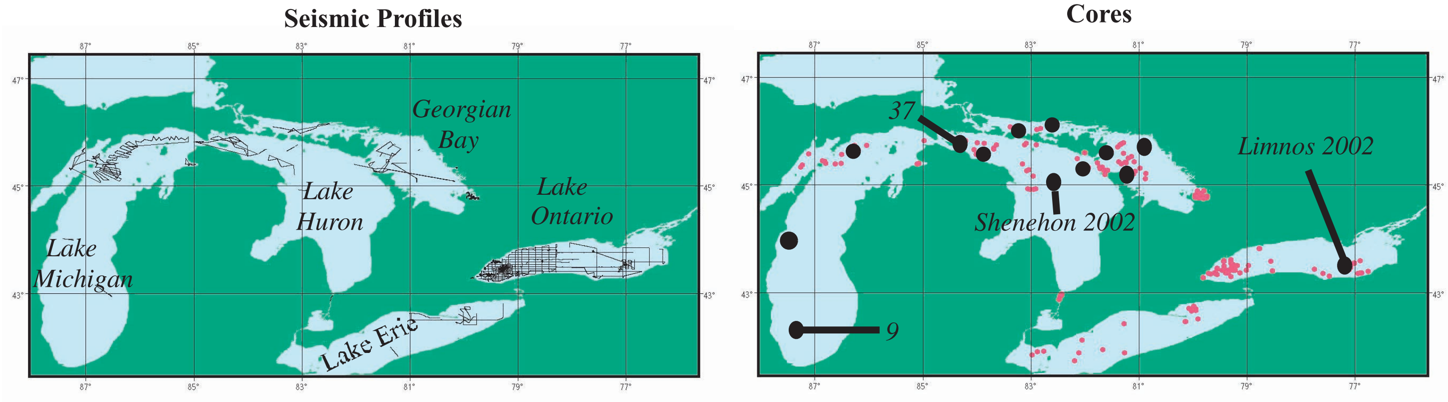


Figure 11. Existing selected seismic profiles and cores. Black dots in Lakes Michigan and Huron (excluding 9 and 37) comprise a network of cores for analysis to constrain source of $\delta^{18}O$-depleted water at 7.9 - 7.5 ka.

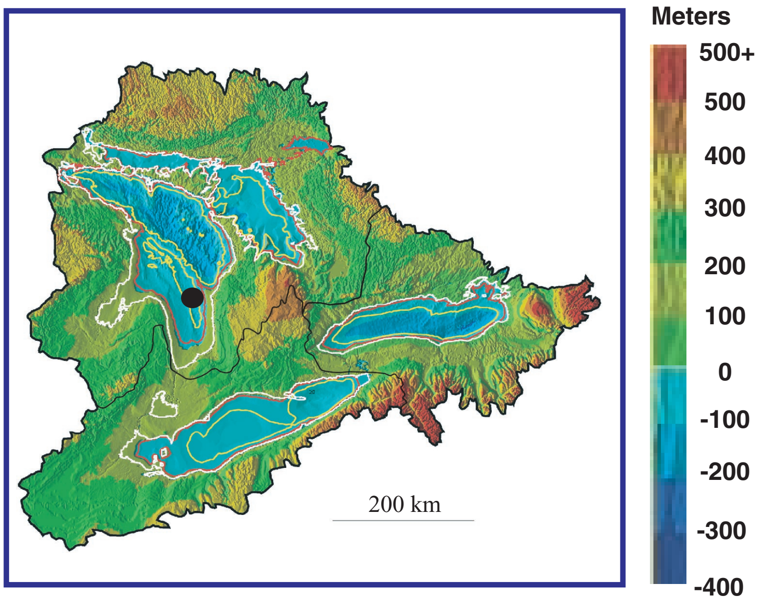


Figure 12. Reconstruction of the paleogeography of the Huron, Erie and Ontario basins at 7600 14C BP showing posited shorelines of the closed lowstands (yellow) relative to potential open lake shorelinees (red) and present shorelines (white). Goderich sub-basin (black dot) in southern Lake Huron is indicated. Paleotopography and paleobathymetry were digitally reconstructed from a digital elevation model of the modern Great Lakes (Figure 1) by removing the effects of post-7600 BP glacial rebound using geographic information system data processing.

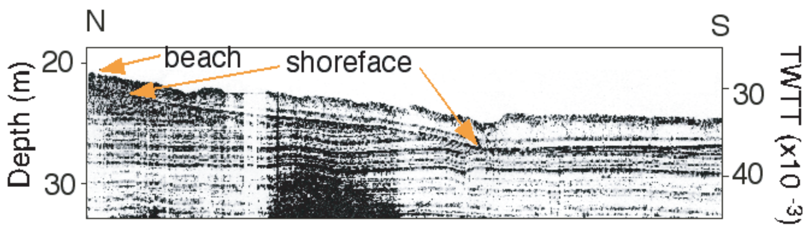


Figure 13. High-resolution seismic profile from eastern Lake Erie showing a beach and mud-buried erosional shoreface of an early Holocene lowstand 21-26 m below present lake level *(55).*

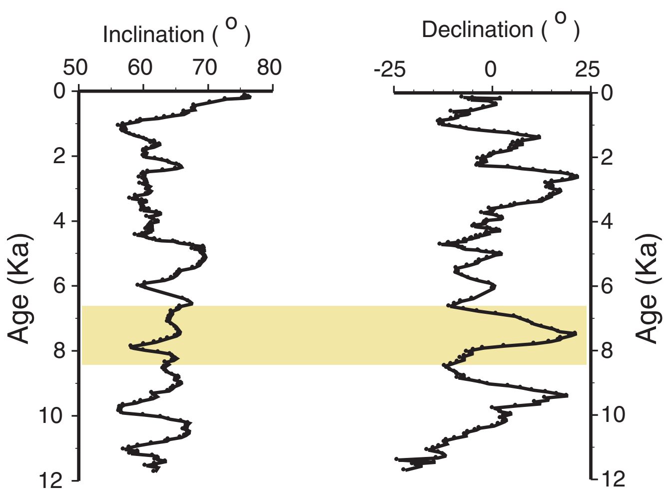


Figure 14. Regional secular variation records for the Northeastern United States *(71).* Yellow shading highlights area of interest. Our approach will be to do secular variation studies on new and existing cores, and correlate these cores to the regional secular variation records to identify the interval of interest (8.4 - 6.8 ka). Detailed climate proxy studies, and AMS 14C dating will then be done on samples obtained from the interval of interest.

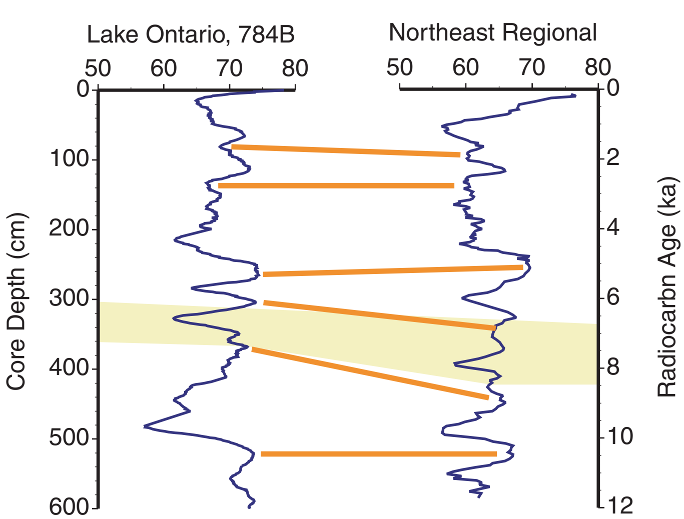


Figure 15. Paleomagnetic inclination of a Lake Ontario core (labelled "Limnos 2002" in Figure 11) correlated to the 14C-dated reference inclination record for the northeastern USA *(71).* A zone of condensed (slower) sediment accumulation (yellow band) between 8.4 and 6.7 ka may indiate a period of lowered lake level with reduced shore erosion and sediment supply consistent with this proposal's hypothesis of a dry climate and lowered water surfaces.

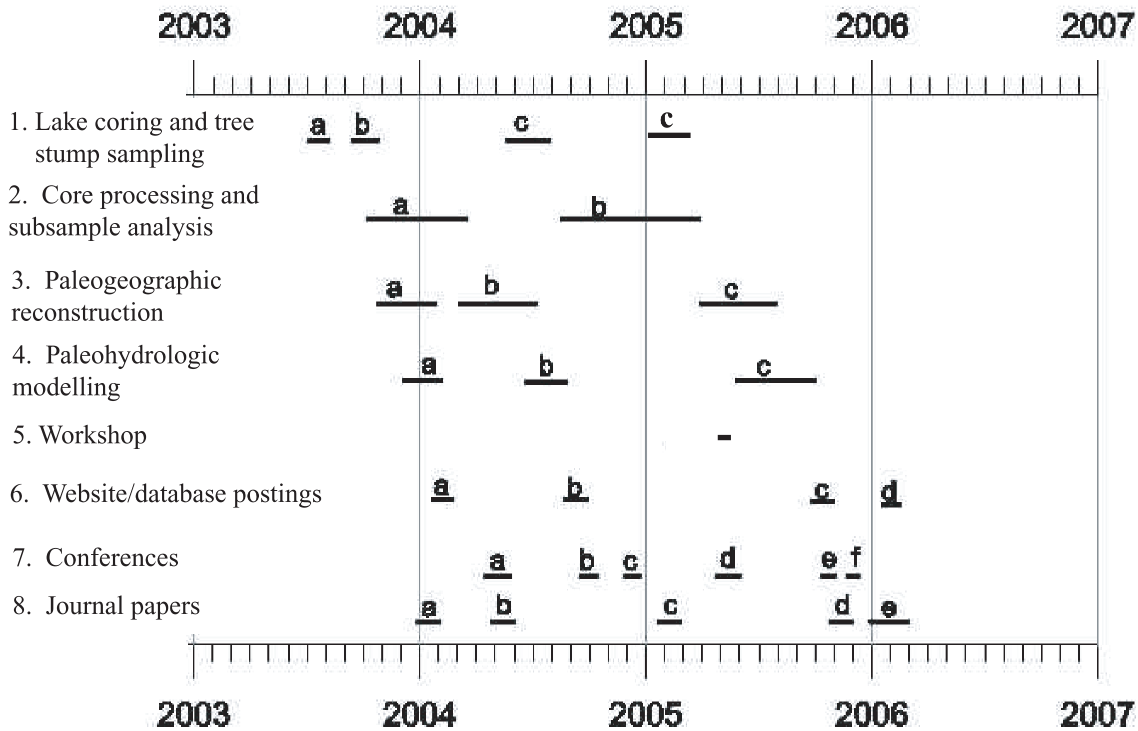


Figure 16.

1. a)Tree stump sampling, entrance to Georgian Bay; b) coring of Erie lowstand beach; c) coring of small lakes, southern Lake Huron and lowstand beach in entrance to Georgian Bay.
2 a) Processing/ analysis for 1 a, b, first proxy estimates of paleoclimate in study interval; b) processing/ analysis for 1 c, final paleoclimate proxy estimates.
3. a) 30 arc-second paleo-Great Lakes poster; b) 3 arc-second Great Lakes digital elevation model (DEM), and paleo-DEMs for study interval and inputs for hydrological modeling; c) DEMs of sampled small lakes.
4. a) Modify present Great Lakes hydrology models for paleo-application; b) construct initial paleo-input climates, and first estimates of Great Lakes sensitivity to high-amplitude climate change; c) final modeling and estimates of Great Lakes sensitivity to high amplitude climate change.
5. Participants workshop to establish paleoclimate change and project results.
6. a-d) Postings of project data and results as information becomes available.
7. a and d) International Association for Great Lakes Research and selected meetings of Canadian Geophysical Union or Geological Association of Canada; b and e) Geological Society of America; c and f) American Geophysical Union.
8. a) Glacial rebound paper; b) Great Lakes closed lowstands paper; c) lake level history papers -Erie, Huron-Michigan basins; d) paleoclimate change and closure of Great Lakes paper, and paleohydrology and lake-level sensitivity paper e) other journal papers led by various project scientists.

Table 1: Characteristics of Small Lakes Proposed for Study

Location	Annual laminations	High quality magnetics record	Seismic studies	Bathymetry maps available	Previous proxy-climage studies of sediment cores
Lake of the Clouds, MN	yes	yes	no	yes	yes
Fayetteville-Green Lake, NY	yes	unknown	yes	yes	yes
Jack Lake, Ontario	no	unknown	no	yes	yes
Found Lake, Ontario	yes	unknown	no	yes	yes
Pretty Lake, IN	no	unknown	no	yes	yes
Lake LeBoeuf, PA	no	yes	no	yes	yes
Derby Lake, MI	yes	yes	no	yes	yes

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I. Education

B.A. 1975 (Special Studies: biology, geology, and chemistry, with honors in biology)
Franklin & Marshall College

Ph.D. 1983 (Geology and Geophysics)
University of Minnesota

Employment

09/83-08/84	Post-Doctoral Fellowship, University of Minnesota
08/84-06/89	Assistant Research Professor, University of Rhode Island
06/89-06/92	Assistant Professor, University of Rhode Island
06/92-06/01	Associate Professor, University of Rhode Island
07/01-present	Professor, University of Rhode Island

Research Interests

Paleomagnetic studies and dating, environmental magnetic studies, paleoclimate studies, trace metal geochemistry

II. Professional Service

09/88-06/93	Member ODP Shipboard Measurements Panel
12/88-12/90	AGU Paleoceanography Committee
09/90-09/93	Member PALE (Paleoclimate of Arctic Lakes and Estuaries) Steering Committee
10/94-10/2000	Member and Chair (09/96-10/00), University of Minnesota, Institute of Rock Magnetism Review and Advisory Committee
10/00-present	Associate Editor, *Estuaries*

III. Professional Affiliations

American Quaternary Association
American Geophysical Union
Geological Society of America
American Association of Stratigraphic Palynologists
Sigma Xi

IV. Publications Appropriate to This Proposal:

Colman, S. M., R. M. Forester, R. L. Reynolds, D. S. Sweetkind, J. W. King, P. Gangemi, G. A. Jones, L. D. Keigwin, and D. S. Foster, 1994. "Lake-level history of Lake Michigan for the past 12,000 years: The record from deep lacustrine sediments," Jour. Great Lakes Res., 20: 73-92, 1994

Colman, S. M., J. W. King, G. A. Jones, R. L. Reynolds, M. H. Bothner, 2000. Holocene and recent sediment accumulation rates in southern Lake Michigan. Quat. Sci. Rev., 19: 1563-1580.

Lewis, C. F. M., D. L. Forbes, B. J. Todd, E. Nielsen, L. H. Thorleifson, T. W. Anderson, R. N. Betcher, W. M. Buhay, S. M. Burbidge, C. Gibson, P. J. Henderson, C. A. Jarrett, J. W. King, H. J. Kling, W. M. Last, W. L. Lockhart, G. Matile, I. McMartin, K. Moran, J. Risberg, C. G. Rodrigues, C. J. Schroder-Adams, A. M. Telka, and R. E. Vance, 2001.. Uplift-driven expansion delayed by middle Holocene desiccation in Lake Winnipeg, Manitoba, Canada. Geology, 29, 743-746.

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King, J. and J. Peck, 2001. Use of paleomagnetism in studies of lake sediments, *In:* Last, W.M. and J.P. Smol (eds*.), Tracking Environmental Change Using Lake Sediments: Physical and Chemical Techniques*, Kluwer Academic Publishers, Dordrecht, The Netherlands, in press, 2001.

King, J. W., C. F. M. Lewis, J. B. Hubeny, K. Moran, D. Coleman, and J. P. Coakley, 2003. Understanding sensitivity of Great Lakes water levels to climatic forcing: Closed-Lake Status 8.4 - 6.8 KA (9400-7700 CAL BP), Abstract and Poster presented at the Third International Limnogeology Congress, Tuscon, Arizona, 29 March - 2 April, 2003.

Recent Publications:

Lacey, E.M., J.W. King, J.G. Quinn, and E.L. Mecray, 2001. Sediment quality in Burlington Harbor, Lake Champlain, U.S.A., Water, Air, and Soil Poll., 126(2): 97-120.

Mecray, E.L., J.W. King, P.G. Appleby, and A.S. Hunt, 2000. Historical trace metal accumulation in the sediments of an urbanized region of the Lake Champlain Watershed, Burlington, Vermont, Water, Air, and Soil Poll., 125(1-4): 201-230.

Katari, K., L. Tauxe, and J. King,, 2000. A reassessment of post-depositional remanent magnetism: Preliminary experiments with natural sediments, Earth Planet. Sci. Lett., 183: 147-160.

Scholz, C. A., J. W. King, G. S. Ellis, P. K. Swart, J. C. Stager, and S. M. Colman, in press. Paleolimnology of Lake Tanganyika, East Africa, over the past 100 Kyr.

Kashiyama, Y., D. E. Fastovsky, S. Rutherford, J. King, and M. Montellano, in press. Genesis of a locality of exceptional fossil preservation: paleoenvironments of Tepexi de Rodgriguez (mid-Cretaceous, Puebla, Mexico). Cretacous Research.

V. Graduate Students/Post-Doctoral Scholars Advised

Graduate Students:

1. Dr. Seong-Jae Doh, Ph.D., 1989
2. Mr. Jeffrey Corbin, MS, 1989
3. Dr. Frank R. Hall, Ph.D., 1991
4. Ms. Lei Peng, MS, 1991
5. Ms. Ellen Mecray, MS, 1994
6. Dr. John Peck, Ph.D., 1995
7. Dr. Elizabeth Lacey, Ph.D., 1997
8. Ms. Kathryn Ford, Ph.D., 09/98-present
9. Mr. Clifford Heil, PhD, 01/99-present
10. Mr. Bradford J. Hubeny, Ph.D., 09/00-present
11. Mr. Mark Cantwell, Ph.D., 09/03 - present
12. Mr. Junsheng Nie, Ph.D.,
13. Ms. Nicolle Whittier, MS, 09/03 - present

Post-Doctoral Scholars:

1. Dr. Jan Bloemendal, 1984-1991
2. Dr. John Peck, 1995-1997
3. Dr. Elizabeth Lacey, 1998

VI. List of Collaborators and Long-term Associates

1. Dr. Subir Banerjee, University of Minnesota, Graduate Advisor
2. Dr. Herbert Wright, University of Minnesota, Graduate Advisor
3. Dr. Peter Appleby, University of Liverpool
4. Dr. Peter deMenocal, LDGO
5. Dr. Douglas Williams, University of South Carolina
6. Dr. Richard Reynolds, USGS
7. Dr. Steve Colman, USGS
8. Dr. Christopher Scholz, Syracuse University
9. Dr. Jonathan Overpeck, University of Arizona

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I. Education

B.A.	1960 (Physics and Geology) University of Toronto	
M.A	1963 (Geology) University of Toronto	
Ph.D.	1967 (Geology and Geophysics) University of Toronto)	

Employment

1961-1964	Research Associate, Great Lakes Institute, University of Toronto
1965-1984	Scientist and Research Scientist, Geological Survey of Canada
1984-1997	Senior Research Scientist, Geological Survey of Canada
1997-present	Emeritus Scientist, Geological Survey of Canada
2003-	Visiting Scientist, University of Rhode Island

Research Interests

Marine geology, Quaternary geology, paleolimnology, paleoclimatology, acoustic/seismic stratigraphy, engineering geology, glacial rebound, neotectonics

II. Professional Service

1980-1982	Member, Committee on Arctic Seafloor Engineering, Marine Board, National Research Council, Washington DC.
1980-1986	Member and Chair (1984-1986), Ice Scour Committee, Environmental Studies Research Funds, Ottawa ON
1999-2002	Member, Grant Selection Committee for Environmental Earth Sciences, Natural Sciences and Engineering Research Council of Canada
2002-2007	Member, Selection Committee for Huntsman Award, Canadian recognition of excellence in international Marine Science

III. Professional Affiliations

Canadian Quaternary Association
International Association for Great Lakes Research
Geological Society of America
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Geological Association of Canada
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IV. Publications

Recent Publications:

Lewis, C.F.M., Forbes, D.L., Todd, B.J., Nielsen, E., Thorleifson, L.H., Henderson, P.J., McMartin, I., Anderson, T.W., Betcher, R.N., Buhay, W.M., Burbidge, S.M., Scr der-Adams, C.J., King, J.W., Moran, K., Gibson, C., Jarrett, C.A., Kling, H.J., Lockhart, W.L., Last, W.M., Matile, G.L.D., Risberg, J., Rodrigues, C.G., Telka, A.M. and Vance, R.E.. 2001. Uplift-driven expansion delayed by middle Holocene desiccation in Lake Winnipeg, Manitoba, Canada. Geology, 29, 743-746.

Anderson. T.W. and Lewis, C.F.M. 2002. Upper Great Lakes climate and water-level changes 11 to 7 ka: Effect on the Sheguiandah archeological site. Chapter 8 in: Julig, P.G. (ed.), The Sheguiandah Site, archeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario. Mercury Series, Archeological Survey of Canada Paper 161, Canadian Museum of Civilization, Ottawa, pp. 195-234.

Lewis, C.F.M., Mayer, L.M., Mukhopadyay, P.K., Kruge, M.A., Coakley, J.P., and Smith, M.D. 2000. Multibeam sonar backscatter lineaments and anthropogenic organic components in lacustrine silty clay, evidence of shipping in western Lake Ontario. International Journal of Coal Geology 43, 307-324.

Moore, Jr., T.C., Walker, J.C.G., Rea, D.K., Lewis, C.F.M., Shane, L.C.K. and Smith, A.J. 2000. Younger Dryas interval and outflow from the Laurentide ice sheet. Paleoceanography 15, 4-18.

Todd, B.J., Lewis, C.F.M., Nielsen, E., Thorleifson, L.H., Bezys, R.K. and Weber, W. 1998. Lake Winnipeg: geological setting and sediment seismostratigraphy. Journal of Paleolimnology 19, 215-244.

Publications Appropriate to This Proposal

Lewis, C.F.M., Moore, T.C. Jr., Rea, D.K., Dettman, D.L., Smith, A.J. and Mayer, L.A. 1994. Lakes of the Huron basin: their record of runoff from the Laurentide Ice Sheet. Quaternary Science Reviews, v.13, pp. 891-922.

Rea, D.K., Moore, Jr., T.C., Anderson, T.W., Lewis, C.F.M., Dobson, D.M., Dettman, D.L., Smith, A.J. and Mayer, L.A. Great Lakes paleohydrology: complex interplay of glacial meltwater, lake levels, and sill depths. Geology 22, 1059-1062.

Anderson, T.W. and Lewis, C.F.M. 1992. Climatic influences of deglacial drainage changes in southern Canada at 10 to 8 ka suggested by pollen evidence. G ographie et Quaternaire 46, 255-272.

Lewis, C.F.M. and Anderson, T.W. 1992. Stable isotope (O and C) and pollen trends in eastern Lake Erie, evidence for a locally-induced climatic reversal of younger Dryas age in the Great Lakes basin. Climate Dynamics 6, 241-250.

Lewis, C.F.M. and Anderson, T.W. 1989. Oscillations of levels and cool phases of the Laurentian Great Lakes caused by inflows from glacial Lakes Agassiz and Barlow-Ojibway. Journal of Paleolimnology 2, 99-146.

V. Graduate Students Co-Advised

1. Dr. Patrick McLaren, Ph.D, 1975
2. Mr. Roland Wahlgren, MSc., 1977
3. Mr. Brian Todd, MSc., 1984
4. Ms. Marylin Segall, MSc., 1986
5. Mr. Gordon Cameron, MSc., 1992
6. Mr. Rolf Pippert, MSc., 1993

VI. List of Collaborators and Long-term Associates

1. Dr. T.W. Anderson, Canadian Museum of Nature
2. Dr. L.H. Thorleifson, University of Minnesota and Geological Survey of Minnesota .
3. Dr. B.J. Todd, Geological Survey of Canada
4. Dr. D.L. Forbes, Geological Survey of Canada
5. Dr. E. Nielsen, Manitoba Geological Survey
6. Dr. T.C. Moore, Jr., University of Michigan
7. Dr. D.K. Rea, University of Michigan
8. Dr. L.A. Mayer, University of New Hampshire
9. Dr. J.P. Coakley, National Water Research Institute, Canada
10. Dr. J. W. King, University of Rhode Island

Biographical Sketch: KATHRYN MORAN

Dept. of Ocean Engineering and Graduate School of Oceanography
University of Rhode Island
South Ferry Rd., Narragansett, RI 02882-1197
Tel. 401-874-6421; Fax: 401-874-6811; e-mail: kate.moran@uri.edu

Education

B. Sc., 1977	Civil Engineering, University of Pittsburgh
M. Sc., 1980	Ocean Engineering, University of Rhode Island
Ph.D., 1995	Civil Engineering, Dalhousie University

Employment

2001 -	Director, Marine Geomechanics Laboratory, University of Rhode Island
2000 -	Associate Professor, Graduate School of Oceanography and Department of Ocean Engineering, University of Rhode Island
1998-2000	Director, Ocean Drilling Programs, Joing Oceanographic Institutions
1997 -	Adjunct Professor, Faculty of Graduate Studies, Dalhousie University
1983-1998	Research Engineer, Geological Survey of Canada
1981-1983	Geotechnical Engineer, J. M. O'Connor Associates, Calgary, Alberta
1979-1981	Research Assistant, University of Rhode Island

Publications Appropriate to This Proposal:

Mosher, D. C., Moran, K., and Hiscott, R. N., 1994. Late Quaternary sediment, mass-flow processes and slope stability on the Scotian Slope, Canada. Sedimentology, 41, p. 1039-1061.

Mulder, T., and Moran, K., 1995. Relationship among submarine instabilities, sea level variations, and the presence of an ice sheet on the continental shelf: An example from the Verrill Canyon Area, Scotian Shelf. Paleoceanography, 10, pp. 137-154.

Moran, K., and Jarrett, C. A., 1998. Lake Winnipeg sediment physical properties applied to the development of a composite stratigraphy and as groundtruth to high resolution seismic reflection data, v. 19 no. 3, Jour. of Paleolimnology, p. 245-253.

Moran, K., and Fader, G. B. J., 1998. Glaciomarine seismic features and groundtruth: Halibut Channel, Grand Banks of Newfoundland, in Davies, T., et al. (eds), Glaciated Continental Margins: An Atlas of Acoustic Images, Chapman & Hall, London, 296 p.

Mosher, D. C. and Moran, K., 2001. Post-glacial evolution of Saanich Inlet, British Columbia: results of physical propoerties and seismic reflection stratigraphy analysis. Marine Geology.

Recent Publications

Moran, K., Hill, P. R., and Blasco, S. M., 1989. Interpretation of piezocone penetrometer profiles in sediment from the Mackenzie Trough, Canadian Beaufort Sea. Journal of Sedimentary Petrology, v. 59, no. 1., pp. 88-97.

Moran, K., and Piper, D.J.W., 1989. Landsliding in Canada: Atlantic and Arctic Offshore, in Proceedings of the International Geographical Congress, Washington D.C., July.

Moran, K., 1993. Offshore site investigations on Canadian continental margins, in Proceedings of the Fourth Canadian Marine Geotechnical Conference, St. John's, Nfld.

Moran, K., 2000. Deepwater Technology in the International OceanDrilling Program, International Ocean Drilling Proceedings, Paper no. 12179, Houston, Texas, U.S.A., 1-4 May.

Moran, K., 2001. Deep sea drilling: methodology, in J. Steele, S. Thrope, and K. Turekian (eds)., Encyclopedia of Ocean Sciences, Academic Press Ltd., London.

Symergistic Activities

Conducted engineering studies on seafloor hazards related to offshore hydrocarbon exploration integrated marine geological studies with engineering constraints. Worked with a team of experts to develop the technical aspects for Arctic drilling. As Program Manager for the Ocean Drilling Program, managed a $46.1M annual science budget. Served as Project Manager for Sea Map, a program to systematically map Canada's offshore lands for sustainable ocean management. Developed and managed a grant program for oil and gas related research for the Atlantic Canada Petroleum Institute (under contract through the University of Rhode Island). Served for 13 years in the advisory structure of the Ocean Drilling Program on panels and committees as a member and chair, most recently serving as Co-Chair of the Integrated Ocean Drilling Program Technical Advisory Panel.

Collaborators

Dr. Jan Backman, Prof., Univ. of Stockholm
Dr. Kathryn Gillis, Assoc. Prof., Univ. of Victoria
Dr. Phil Hill, Research Scientist, Geological Survey of Canada
Dr. Gary Greene, MBARI
Dr. David Farmer, Dean, GSO, URI
Dr. Larry Mayer, Prof. and Director, Center for Coastal and Ocean Mapping
Dr. David C. Mosher, Research Scientist, Geological Survey of Canada
Dr. David J. W. Piper, Research Scientist, Geological Survey of Canada
Dr. Armand Silva, Emeritus, URI
Jr. Jim Wooder, Executive Director, Petroleum Research Atlantic Canada

Graduate Advisors

Prof. Hans Vaziri, Univ. of Western Ontario
Prof. Geoff Meyerhof, Dalhousie University (deceased)
Prof. Armand Silva, Emeritus, URI

Graduate Students

Veith Atlmann, M. S. Candidate, Civil Engineering
Jennifer Henderson, M. S. Candidate, Ocean Engineering
Matthew O'Regan, Ph.D. Candidate, Graduate School of Oceanography
Ines Waltham, M. S. Candidate, Ocean Engineering

CURRICULUM VITAE

DAVID L. DETTMAN

Research Scientist
Geosciences Department
University of Arizona

University of Arizona
Geosciences Department
Tucson, AZ 85721
dettman@geo.arizona.edu
(520) 621-4618

(i).

Education:
- B.A. 1980 University of Michigan (Medieval and Renaissance Studies)
- M.A. 1989 University of Michigan (History)
- M.S. 1991 University of Michigan (Geology)
- Ph.D. August 1994 University of Michigan (Geology)

Dissertation Title: Stable Isotope Studies of Fresh-Water Bivalves (Unionidae) and Ostracodes (Podocopida): Implications for Late Cretaceous / Paleogene and Early Holocene Paleoclimatology and Paleo-Hydrology of North America.

(ii).

University of Arizona — Department of Geosciences
- 8/2002 – **present** Research Scientist

Shimane University (Japan) — Research Center for Coastal Lagoon Environments
- 7/2003 – **present** Guest Research Professor (1 year)

University of Arizona — Department of Geosciences
- 8/1995 – 8/2002 Senior Research Specialist

University of Michigan — Department of Geological Sciences
- 9/1993 - 5/1994 Graduate Research Assistant
- 9/1992 - 9/1993 Rackham Pre-Doctoral Fellow
- 9/1989 - 9/1992 National Science Foundation Graduate Research Fellow
- 1980 - 9/1989 Research Associate, Technician and Supervisor

(iii).

i. Publications related to the proposed project:

Dettman, David L., A. J. Smith, D. K. Rea, K. C Lohmann and T. C. Moore Jr., **1995**, Glacial melt-water in Lake Huron during early post-glacial times as inferred from single-valve analysis of oxygen isotopes in ostracodes, *Quaternary Research,* v. 43, pp. 297-310. http://dx.doi.org/10.1006/qres.1995.1036

Dettman, D.L. Fang, X., Garzione, C.N., Li, J., **2003**, Uplift-driven climate change at 12Ma: a long $\delta^{18}O$ record from the NE margin of the Tibetan plateau, *Earth and Planetary Science Letters* v. 214, pp. 267-277. http://dx.doi.org/10.1016/S0012-821X(03)00383-2

Dettman, David L., A. K. Reische, and K. C Lohmann, **1999**, Controls on the stable isotope composition of seasonal growth bands in aragonitic fresh-water bivalves (*Unionidae*), *Geochimica et Cosmochimica Acta*, v. 63, pp. 1049-1057. http://dx.doi.org/10.1016/S0016-7037(99)00020-4

Dettman, David L. and K.C Lohmann, **1995**, Microsampling carbonates for stable isotope and minor element analysis: Physical separation of samples on a 20 micrometer scale, *Journal of Sedimentary Petrology,* v. A65, pp. 566-569.

Rea, D.K., T.C. Moore Jr., T.W. Anderson, C.F.M. Lewis, D.M. Dobson, D.L. Dettman, A.J. Smith, and L.A. Mayer, **1994**, Great Lakes paleohydrology: Complex interplay of glacial melt water, lake levels, and sill depths, *Geology*, v. 22, pp. 1059-1062.

ii. Additional Recent Publications:

Dettman, D.L., K.W. Flessa, P.D. Roopnarine, B.R. Schöne, D.H. Goodwin, **in press,** *Geochimica et Cosmochimica Acta*, The use of oxygen isotope variation in shells of estuarine mollusks as a quantitative record of seasonal and annual Colorado River discharge. To be published in November (?) 2003.

Goodwin, D.H., B.R. Schöne, and D.L. Dettman, **2003**, Effects of sample resolution and sample completeness on estimates of isotopic variation in shells of bivalve mollusks: Models and observations. *Palaios*, v. 18, pp. 110-125.

Dettman, David L., Matthew J. Kohn, Jay Quade, F. J. Ryerson, Tank P. Ojha, and Seyd Hamidullah, **2001**, Seasonal stable isotope evidence for a strong Asian Monsoon throughout the last 10.7 Ma, *Geology*, v. 29, pp. 31-34.

Dettman, D.L., **2001**. Paleo breakfast, lunch, and dinner: Ultra high-resolution sampling and what lies behind a single drill hole. *GSA Annual Meeting.*

Rodriguez, C.A., K.W. Flessa, and D.L. Dettman, **2001**, Effects of upstream diversion of Colorado River water on the estuarine bivalve mollusc *Mulinia coloradoensis*, *Conservation Biology*, v. 15, pp. 249-258.

(iv). Synergistic Activities

Development of high resolution [10 micron] sampling techniques for stable isotope analysis (Dettman and Lohmann, 1995, above). This became the prototype of New Wave / Merchantek micromilling device, currently used in many laboratories.

Team-teaching a graduate seminar in Stable isotopes and Paleoenvironments, 3 hours per week, one semester in each of 1998, 1999, 2001, 2003 – no credit or compensation is given to me in return for this service to the department.

Development of a Graduate Seminar in Stable isotopes and ecology, 2 hours per week, Spring 2002. This class focuses on the use of stable isotope techniques in the study of the ecology and paleoecology of the Colorado River delta.

(v).

a. Other collaborators not listed in publications:

Robert Butler (University of Arizona)
Andrew Cohen (University of Arizona)
Owen Davis (University of Arizona)
Pete DeCelles (University of Arizona)
Yongwen Gao (Makah Tribal Fisheries)
Anthony A. T. Jull (University of Arizona)
Darryl Kaufman (Northern Arizona University)
John King (University of Rhode Island)
Steve Nelson (Brigham Young University)
Lisa Park (University of Akron)
Manuel Palacios-Fest (University of Arizona)
Saburo Sakai (Japan Marine Science & Technology Center)
Katsumi Takayasu (Shimane University)
Kazushige Tanabe (University of Tokyo)
David Williams (University of Wyoming)

b. Graduate Advisor:

K. C Lohmann (University of Michigan)

c. Student advising (as a committee member) – 14 students total. No Post-doctoral researchers.

Jennifer Becker (MS)
Tara Curtin (PhD)
Nathan English (PhD)
Fan Majie (MS)
Carmala Garzione (PhD)
David Goodwin (PhD)
Naomi Levin (MS)
Carrie Morril (PhD)
Catherine O'Reilly (PhD)
Carlie Rodriguez (MS)
Mark Rollog (MS)
Kirsten Rowell (PhD)
Donna Surge (PhD)
Ta-Shana Taylor (MS)

ALISON JEAN SMITH
BIOGRAPHICAL SKETCH

Work Address: Department of Geology, Kent State University, Kent, Ohio, 44242, Telephone (330)-672-3709, email asmith@geology.kent.edu, FAX (330)-672-7949.

Education

Wheaton College, Massachusetts	Anthropology	B.A., 1979
Cambridge University, England	Archaeology	M.Ph., 1980
University of Delaware, Delaware	Geology	M.Sc., 1987
Brown University, Rhode Island	Geology	Ph.D., 1991

Appointments:
Professor 8/01 to present
Associate Professor 8/95 to 8/01
Assistant Professor 8/90-8/95

Five Most Relevant Papers

Smith, A.J., Donovan, J.J., Ito, E., Engstrom, D.R., and Panek, V., 2002. Climate driven hydrologic transients in lake sediment records: multiproxy record of mid-Holocene drought. *Quaternary Science Reviews* 21/4-6 pp. 625-646

Donovan, J.J., Smith, A.J., Ito, E., Engstrom, D.R., and Panek, V. 2002. Climate driven hydrologic transients in lake sediment records: calibration of groundwater conditions to 20th century drought, *Quaternary Science Reviews*, 21/4-6, pp. 595-624.

Smith, A.J. and Horne, D., 2002. Ecology of Marine, Marginal Marine, and Nonmarine Ostracods, in *The Ostracoda: Applications in Quaternary Research*, *Geophysical Monograph Series*, edited by A. R. Chivas and J. A. Holmes, Chapter 2, pp. 37-64, American Geophysical Union, Washington, D. C.

Smith, A.J., Donovan, J.J., Ito, E., and Engstrom, D.R., 1997. Ground-water processes controlling a prairie lake's response to middle Holocene drought, *Geology*, v. 25, p. 391-394.

Dettman, D., Smith, A.J., Rea, Moore, T.C., Jr., and D.K., Lohmann, K.C., 1995. Glacial meltwater in Lake Huron during early postglacial time as inferred from single valve analysis of oxygen isotopes in ostracodes, *Quaternary Research*, 43, 297-310.

Five Additional Papers
Moore, T.C., Jr., Walker, J.C.G. , Rea, D.K. , Lewis, C.F.M., Shane, L.C.K., Smith, A.J., 2000. Younger Dryas interval and outflow from the Laurentide ice sheet , *Paleoceanography.* 15 , No. 1 , p. 4-18.

Vance, R.E., Last, W.M. and Smith, A.J., 1997. Hydrologic and climatic implications of a multidisciplinary study of late Holocene sediment from Kenosee Lake, southeastern Saskatchewan, Canada, *J. Paleolimnology*, 18, 365-393..

Rea, David K., Moore, T.C., Jr., Anderson, T.W., Lewis, C.F.M., Dobson, D.M., Dettman, D.L., Smith, A.J., and Mayer, L.A., 1994, Great Lakes paleohydrology: complex interplay of glacial meltwater, lake levels, and sill depths, *Geology*, v.22, p. 1059-1062.

Smith, A.J., 1993. Lacustrine ostracodes as hydrochemical indicators in lakes of the north-central United States, *J. Paleolimnology*, 8, 121-134.

Smith, A.J., Delorme, L.D., and Forester, R.M., 1992. A lake's solute history from ostracodes: comparison of methods, IN Kharaka, Y.K. and Maest, A.S. (eds.) Water-Rock Interaction, Proceedings of the 7th International Symposium on Water-Rock Interaction, p. 677-680.

Synergistic Activities

1. Innovations in Teaching:
   a. Micropaleontology course: Introducing and using multivariate statistical analysis into the course in order to teach management and assessment of large datasets, a common feature of microfossil study.
   b. Paleolimnology course: Development of a course combining hands-on field methodology, including sediment coring, and lab analysis in order to teach data assessment.
   c. Water and Society course: Development of an Honors Level interdisciplinary course to teach fundamental issues of water management and control linked to economics, politics, geology, and history.
2. Development of an on-line database to support research:
   a. North American Ostracode Database (NANODe), currently under construction at KSU (version 1 now *in review*), will provide hydrochemical and climate data associated with ostracode fauna from 600 sites in the United States will be available on the world wide web and as a CD. Collaborators are listed in section E.

Collaborators & Other Affiliations

1. Collaborators:

		Emi Ito	University of Minnesota
Brandon Curry	Illinois Geol. Survey	C.F. Michael Lewis	Canada Geol. Survey
Dave Dettman	University of Arizona	K. C. Lohmann	University of Michigan
Joe Donovan	West Virginia University	Ted Moore	University of Michigan
Dan Engstrom	Science Museum, MN	Barry Miller	Kent State University
Rick Forester	U.S. Geological Survey	Don Palmer	Kent State University
Sheri Fritz	University of Nebraska	Lisa Park	University of Akron
Dave Horne	University of Greenwich	Dave Rea	University of Michigan
Eric Grimm	Illinois Natural History Museum	Linda Shane	University of Minnesota
		Bob Vance	Canada Geol. Survey

Graduate Students: Joan C. Puller, M.S. 1994; John Carney, M.S. 1997; Dana Oleskoweicz, M.S. 1998; Sonia Bacon, M.S. 1999, Bonnie Muller, M.S., 2001, Timothy Cosma, M.S., 2002, Colleen Jones, M.S., 2002. Current: Karen Traugh, Ph.D. student.

Ph.D. Thesis Advisor: Thompson Webb, III. M.S. Advisor: Fred Swain, M.Ph. Advisor, John Coles

DAVID K. REA
September, 2003

Office Address

Department of Geological Sciences
The University of Michigan
Ann Arbor, Michigan 48109-1063
(734) 936-0521

Education

A.B., Princeton University, 1964.
  Major: Geology
M.S., University of Arizona, 1967.
  Major: Sedimentation/Stratigraphy
Ph.D., Oregon State University, 1974.
  Major: Geological Oceanography; Minor: Geophysics

Professional Experience

1975-present: Assistant Professor (1975-1980), Associate Professor (1980-1986), Professor (1986-), University of Michigan, Ann Arbor, Michigan
2002: Visiting Scientist, Department of Earth Sciences, UC Santa Cruz
1995-2000: Chair, Department of Geological Sciences, University of Michigan
1988-1989: Interim Director, Center for Great Lakes and Aquatic Sciences,University of Michigan, Ann Arbor, Michigan
1986-1987: Associate Director, Climate Dynamics Program, Atmospheric Sciences Division, National Science Foundation, Washington, D.C.
1982-1983: Visiting Associate Professor, College of Oceanography, Oregon State University, Corvallis, Oregon
1974-1975: Assistant Professor, School of Oceanography, Oregon State University, Corvallis, Oregon

Recent Research Cruise Participation

JOIDES Resolution, Leg 121, eastern Indian Ocean, May-June, 1988, sedimentologist
Thomas Washington, eastern Equatorial Pacific, August-October, 1989
Laurentian, Lake Huron, June, 1990, co-chief scientist
Laurentian, Lake Huron, August-September, 1991, co-chief scientist
JOIDES Resolution, Leg 145, North Pacific, July-September, 1992, co-chief scientist
Laurentian, Lakes Michigan and Huron, July-August, 1995, co-chief scientist
JOIDES Resolution, Leg 199, North Pacific, October-December, 2001, sedimentologist

Selected National and International Committee Participation

Integrated Ocean Drilling Program, IODP Scientific Planning Working Group, 1999-2000; Science Planning and Policy Oversight Committee (SPPOC), 2003-present.
Ocean Drilling Program, Central and Eastern Pacific Regional Panel, 1984-1986, 1987-1990; Chair, Fall 1985 to Summer 1986, and Fall 1987 to Spring 1990. Atolls and Guyots Detailed Planning Group, Chair, Winter/Spring, 1991; Climate and Tectonics Program Planning Group, 1998-1999; JOIDES Science Committee, 2000-2003; Arctic Detailed Planning Group, 2001.
National Science Foundation, Steering Committee for the MESH (Marine aspects of Earth System History) Initiative, 1993-2001.
University of Arizona, Geosciences Advisory Board, 1997-present.
University of Minnesota, External Advisory Group, National Lake Core Facility, 2001-present
American Association for the Advancement of Science, Electorate Nominating Committee, Geology and Geography Section, 1992-1995; Chair, 1994-1995
American Geophysical Union, Committee on Paleoceanography, 1988-1990, 1992-1994. All-Union Committee on Global Environmental Change, Chair, 1993-1996.
Geological Society of America, Technical Program Committee; responsibility for paleoceanography and paleoclimatology, 1990-1992.

Professional Affiliations

American Geophysical Union, Fellow
Geological Society of America, Fellow
American Association for the Advancement of Science
The Oceanography Society

Five references related to this proposal

Rea, D.K., T.C. Moore, Jr., C.F.M. Lewis, L.A. Mayer, D.L. Dettman, A.J. Smith, and D.M. Dobson, 1994. Stratigraphy and paleolimnologic record of lower Holocene sediments in northern Lake Huron and Georgian Bay. *Canadian Journal of Earth Sciences, 31,* p. 1586-1605.

Rea, D.K., T.C. Moore, Jr., T.W Anderson, C.F.M. Lewis, D.M. Dobson, D.L. Dettman, A.J. Smith, and L.A. Mayer, 994. Great Lakes paleohydrology: Complex interplay of glacial meltwater, lake levels, and sill depths. *Geology, 22*, p. 1059-1062.

Lewis, C.F.M., T.C. Moore, Jr., D.K. Rea, D.L. Dettman, A.M. Smith, and L.A. Mayer,1994. Lakes of the Huron basin: Their record of runoff from the Laurentide ice sheet. *Quaternary Science Reviews, 13,* 891-922.

Moore, T.C. Jr., J.C.G. Walker, D.K. Rea, C.F.M. Lewis, L.C.K. Shane, and A. J. Smith, 2000. The Younger Dryas interval and outflow from the Laurentide Ice Sheet. *Paleoceanography, 15,* 4-18.

Odegaard, C., D.K. Rea, and T.C. Moore, Jr., 2003. Stratigraphy of the mid-Holocene black bands in lakes Michigan and Huron: Evidence for possible basin-wide anoxia. *Journal of Paleolimnology, 29*, 221-234.

Five additional references

Rea, D.K., R.M. Owen, and P.A. Meyers, 1981. Sedimentary processes in the Great Lakes. *Reviews of Geophysics and Space Physics, 19,* 635-648.

Harrsch, E.C., and D.K. Rea, 1982. Composition and distribution of suspended sediments in Lake Michigan during summer stratification. *Environmental Geology, 4*, 87-98.

Moore, T.C., Jr., D.K. Rea, L.A. Mayer, C.F.M. Lewis, and D.M. Dobson, 1994. Seismic stratigraphy of Lake Huron - Georgian Bay and post-glacial lake level history. *Canadian Journal of Earth Sciences, 31*, 1606-1617.

Dettman, D.L., A.J. Smith, D.K. Rea, T.C. Moore, Jr., and K.C. Lohmann, 1995. Glacial meltwater in Lake Huron during early post-glacial times as inferred from single-valve analysis of oxygen isotopes in ostracodes. *Quaternary Research, 43,* 297-310.

Godsey, H.S., T.C. Moore, Jr., D.K. Rea, and L.C.K. Shane, 1999. Post-Younger Dryas seasonality in the North American mid-continent region as recorded in Lake Huron varved sediments. *Canadian Journal of Earth Sciences, 36,* 533-547.

Collaborators outside the University of Michigan during the past 48 months

Gerald Dickens, David Scholl, Alex Halliday, Charles Jones, Carrie Odegaard, Thomas Pettke, Michael Lewis, Mitch Lyle, L. Liberty, Leg 199 scientists, Linda Shane, Alison Smith, Andy Stevenson, Hongbo Zheng

Ph.D. advisors: L.D. Kulm (Oregon State Univ.), T.H. van Andel (Cambridge)
Ph.D. students. T. Janecek, S. Hovan, H. Snoeckx, D. Dobson, L. Prueher, L. Joseph

Synergistic Activities:

I engage regularly in teaching and training of both undergraduate and graduate students, varying from large lecture classes to one-on-one instruction and mentoring. Lessons and understandings from research form a regular part of this instruction at all levels. I have contributed significant amounts of time to service on various national and international boards and committees for organizations such as the National Science Foundation, the Ocean Drilling Program, the American Geophysical Union, and the University of Arizona, and serve on the editorial boards of *Geology* and *Paleoceanography*.

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION: University of Rhode Island				FOR NSF USE ONLY: PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: John W King				AWARD NO.		
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)	
1. John W King - PI	0.00	0.00	0.00	$ 0	$	
2. Michael Lewis - Co-PI	0.00	0.00	0.00	0		
3. Kathryn Moran - Co-PI	0.00	0.00	0.00	0		
4.						
5.						
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0		
7. (3) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0		
2. (2) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	5.00	0.00	0.00	17,503		
3. (0) GRADUATE STUDENTS				0		
4. (0) UNDERGRADUATE STUDENTS				0		
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0		
6. (1) OTHER				1,511		
TOTAL SALARIES AND WAGES (A + B)				19,014		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				7,583		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				26,597		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)						
TOTAL EQUIPMENT				0		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				28,000		
2. FOREIGN				0		
F. PARTICIPANT SUPPORT COSTS						
1. STIPENDS $ 0						
2. TRAVEL 0						
3. SUBSISTENCE 0						
4. OTHER 0						
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0		
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES				3,000		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				1,200		
3. CONSULTANT SERVICES				0		
4. COMPUTER SERVICES				1,000		
5. SUBAWARDS				0		
6. OTHER				13,000		
TOTAL OTHER DIRECT COSTS				18,200		
H. TOTAL DIRECT COSTS (A THROUGH G)				72,797		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) On-campus rate (Rate: 44.0000, Base: 72797)						
TOTAL INDIRECT COSTS (F&A)				32,031		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				104,828		
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 104,828	$	
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $					
PI/PD NAME: John W King				FOR NSF USE ONLY: INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*: Mary costa				Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0354762

SUMMARY PROPOSAL BUDGET

YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Rhode Island

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
John W King

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. John W King - PI	0.00	0.00	0.00	$ 0	$
2. Michael Lewis - Co-PI	0.00	0.00	0.00	0	
3. Kathryn Moran - Co-PI	0.00	0.00	0.00	0	
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (3) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (2) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	5.00	0.00	0.00	18,378	
3. (1) GRADUATE STUDENTS				21,638	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (1) OTHER				1,587	
TOTAL SALARIES AND WAGES (A + B)				41,603	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				9,990	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				51,593	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				33,000	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				3,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				1,800	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				1,000	
5. SUBAWARDS				0	
6. OTHER				21,000	
TOTAL OTHER DIRECT COSTS				26,800	
H. TOTAL DIRECT COSTS (A THROUGH G)				111,393	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) On-campus rate (Rate: 44.0000, Base: 103893)					
TOTAL INDIRECT COSTS (F&A)				45,713	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				157,106	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 157,106	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME
John W King

ORG. REP. NAME*
Mary costa

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0354762

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Rhode Island

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
John W King

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. John W King - PI	0.00	0.00	0.00	$ 0	$
2. Michael Lewis - Co-PI	0.00	0.00	0.00	0	
3. Kathryn Moran - Co-PI	0.00	0.00	0.00	0	
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (3) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (2) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	2.50	0.00	0.00	9,648	
3. (1) GRADUATE STUDENTS				23,324	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (1) OTHER				1,666	
TOTAL SALARIES AND WAGES (A + B)				34,638	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				7,076	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				41,714	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				9,000	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				1,500	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				3,000	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				1,000	
5. SUBAWARDS				0	
6. OTHER				14,250	
TOTAL OTHER DIRECT COSTS				19,750	
H. TOTAL DIRECT COSTS (A THROUGH G)				70,464	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) On-campus rate (Rate: 44.0000, Base: 62214)					
TOTAL INDIRECT COSTS (F&A)				27,374	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				97,838	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 97,838	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME
John W King

ORG. REP. NAME*
Mary costa

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0354762

SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION University of Rhode Island				FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed / Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR John W King				AWARD NO.	

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. John W King - PI	0.00	0.00	0.00	$ 0	$
2. Michael Lewis - Co-PI	0.00	0.00	0.00	0	
3. Kathryn Moran - Co-PI	0.00	0.00	0.00	0	
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (3) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (6) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	12.50	0.00	0.00	45,529	
3. (2) GRADUATE STUDENTS				44,962	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (3) OTHER				4,764	
TOTAL SALARIES AND WAGES (A + B)				95,255	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				24,649	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				119,904	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				70,000	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				7,500	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				6,000	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				3,000	
5. SUBAWARDS				0	
6. OTHER				48,250	
TOTAL OTHER DIRECT COSTS				64,750	
H. TOTAL DIRECT COSTS (A THROUGH G)				254,654	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				105,118	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				359,772	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 359,772	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME John W King	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* Mary costa	Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

PROJECT TITLE:	"COLLABORATIVE RESEARCH: Understanding Sensitivity of Great Lakes Water Levels to Climatic Forcing: Closed Lake Status 8.4-6.8KA, 9400-7700 CAL BP"
	As of: 09/18/03rlk
URI COLLABORATIVE INVESTIGATORS:	John W. King, PI and Kathryn Moran, Co-PI
AGENCY/#:	NSF-ATM: TPI#6208481
PERIOD:	December 1, 2003 - November 30, 2006
URI Log #:	
URI BUDGET:	* $359,772

	Mos.	YEAR 1	YEAR 2	YEAR 3	TOTAL
A. SALARIES & WAGES: (Senior Personnel)					
1) King, J.W., PI	(0 / 0 / 0)	0	0	0	0
2) Moran, K., Co-PI	(0 / 0 / 0)	0	0	0	0
3) Lewis, M., Visiting Scientist (Co-PI)	(0 / 0 / 0)	0	0	0	0
Total Senior Personnel		0	0	0	0
B. SALARIES & WAGES: (Other Personnel)					
** 1) Technicians:					
a. Heil, C. (MRS II)	(2 / 2 / 1)	5,596	5,876	3,085	14,557
b. Gibson, C. (MRS IV)	(3 / 3 / 1.5)	11,907	12,502	6,563	30,972
2) Graduate Student (Phd):					
a. Hubeny, B. (L. II, III, resp.)	(0 / 12 / 12)	0	21,638	23,324	44,962
3) SRGA, R. Kenny	(0.5 / 0.5 / 0.5)	1,511	1,587	1,666	4,764
Total Other Personnel		19,014	41,603	34,638	95,255
Total Salaries & Wages		19,014	41,603	34,638	95,255
C. FRINGE BENEFITS:					
** 1) 47% B1a		2,630	2,762	1,450	6,842
** 2) 35% B1b		4,167	4,376	2,297	10,840
3) 7.65% FICA, B2a (summer only); health insurance		0	2,027	2,463	4,490
4) 52% B3		786	825	866	2,477
Total Fringe Benefits		7,583	9,990	7,076	24,649
TOTAL SALARIES/WAGES & FRINGE		26,597	51,593	41,714	119,904
D. PERMANENT EQUIPMENT		0	0	0	0
E. TRAVEL:					
1) Domestic (see justification for breakdown):		28,000	33,000	9,000	70,000
TOTAL TRAVEL		28,000	33,000	9,000	70,000
F. PARTICIPANT SUPPORT COSTS		0	0	0	0
G. OTHER DIRECT COSTS:					
** 1) Materials and Supplies		3,000	3,000	1,500	7,500
2) Publication Costs/Documentation/Dissemination		1,200	1,800	3,000	6,000
3) Consultant Services		0	0	0	0
4) Computer Services/Supplies		1,000	1,000	1,000	3,000
5) Subawards		0	0	0	0
6) Other:					
** a. Paleomagnetics Lab, URI: Includes admin. charges as well as supplies and machine time for analyses		4,500	5,000	2,500	12,000
b. Technical supplies/charges: *(project-related supplies to include some of the following: paper, toner, transparencies, adhesives, mailing supplies, etc.; charges to include: communication--long-distance, I.e. e-mail, fax, telephone; postage--express mail)*		500	500	500	1,500
c. Equipment rentals		2,000	2,000	0	4,000
d. Radiocarbon Dating		6,000	6,000	3,000	15,000
e. Tuition (regional)		0	7,500	8,250	15,750
Total Other		13,000	21,000	14,250	48,250
TOTAL OTHER DIRECT COSTS		18,200	26,800	19,750	64,750
H. TOTAL DIRECT COSTS		72,797	111,393	70,464	254,654
I. INDIRECT COSTS (44% MTDC: excluding D and G6e)		32,031	45,713	27,374	105,118
J. TOTAL DIRECT & INDIRECT		104,828	157,106	97,838	359,772

All expenditures prorated as project-related expenditures per A-21.
****Cost Center: budget items as indicated will be budgeted under URI object code 3455.***

URI Budget Justification

URI is the lead institution for this proposal. In this regard, King and Lewis will coordinate the overall project and participate in all field work. King will supervise the graduate student (Brad Hubeny) and the technicians. King will supervise the magnetics, palynology, and annual lamination studies, distribution of samples to collaborators, and compilation of project data. Lewis will supervise the GIS, seismic, and lithostratigraphy studies and will coordinate the modeling studies. Moran will supervise the physical property (Geotek) studies.

We request 5 months of technician support in years 1 and 2, and 2.5 months in year 3. C. Heil will participate in field work and do paleomagnetic and Geotek logging studies. C. Gibson will do paleomagnetic and geochemical studies, palynology sample preparation and GIS studies. Full time support is requested for Brad Hubeny, a PhD student for years 2 and 3. Mr. Hubeny will complete his thesis work in ~3.5 years. He will participate in field work, geotechnical, paleomagnetic, and lithostratigraphy studies (varve chronology). The paleoclimate synthesis for the target interval will be part of his thesis work. Funds are also requested for grant assistant support (.5mo/yr, R. Kenny) of the project to assist in the procurement of items in support of the research and coordination of logistics in preparation for field work.

The domestic travel budget includes $19,000 in Year 1 and $16,000 in Year 2 for field expenses. It includes $5,000 in Years 1,2, and 3 for travel expenses for Lewis to travel to URI from Halifax and stay at URI for approximately 45 days. It also includes $4,000 in Years 1, 2 and 3 for PI (King, Lewis, and Moran) travel to present results at national meetings. Finally, it includes $8,000 in Year 2 to hold a PI and collaborator's meeting at URI.

Field expenses in Year 1 include expenses for surveying and coring Lake Huron and Lake Erie, expenses for surveying small lakes in Ontario, Michigan, Indiana and Pennsylvania, and expenses for coring small lakes in Michigan, Indiana, and New York by boat (see Table 1). Expenses include rentals for two trucks and one boat ($6,000), fuel and tolls ($1,500), rental fees for seismic gear ($2,000), per diem expenses for a field party of four for 25 days ($9,000), and miscellaneous expenses ($500). Field expenses in Year 2 include expenses for coring small lakes in Minnesota, Ontario, and Pennsylvania (see Table 1). These lakes will be cored from the ice in the winter. Dog sleds will be needed to core Lake of the Clouds. Expenses include rentals for two trucks, snowmobiles, and dogsleds ($5,000), per diem expenses for a field party of four for 22 days ($7,920), fuel and tolls ($1,500) and miscellaneous ($500).

Materials and supplies costs include core liners, D-tubes, coring expendables, liquid gases (helium, nitrogen), chemical reagents, and sampling containers needed to process and distribute all samples. Paleomagnetics Laboratory charges include the machine time costs of using the U-channel magnetometers, Geotek loggers, and other equipment in the URI Paleomagnetics Laboratory to process cores. Equipment rental charges are for use of an X-ray machine to X-ray cores, and for use of a CHN analyzer to analyze samples for carbon and nitrogen.

<u>Leveraged Funds</u>: A total of $212,500 in leveraged funding is available for this project. The Canadian Geological Survey is providing $150,000 U.S. to support Canadian collaborators. The NOAA Great Lakes Environmental Research Laboratory will provide $62,500 to support ship time and the climate modeling studies of Croley. See the attached letters of support for details (ref. I-Supplementary, pp. I17-18).

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION **University of Arizona**			FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **David L Dettman**			AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. David L Dettman - none	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (1) UNDERGRADUATE STUDENTS				1,250	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				1,250	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				59	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				1,309	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				200	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				8,000	
TOTAL OTHER DIRECT COSTS				8,200	
H. TOTAL DIRECT COSTS (A THROUGH G)				9,509	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **total direct (Rate: 50.7930, Base: 9509)**					
TOTAL INDIRECT COSTS (F&A)				4,830	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				14,339	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 14,339	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME **David L Dettman**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Julia Wood**	Date Checked	Date Of Rate Sheet	Initials - ORG

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0355217

SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION University of Arizona				FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR David L Dettman				AWARD NO.		
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)	
1. David L Dettman - none	0.00	0.00	0.00	$ 0	$	
2.						
3.						
4.						
5.						
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0		
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0		
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0		
3. (0) GRADUATE STUDENTS				0		
4. (0) UNDERGRADUATE STUDENTS				0		
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0		
6. (0) OTHER				0		
TOTAL SALARIES AND WAGES (A + B)				0		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				0		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)						
TOTAL EQUIPMENT				0		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				1,000		
2. FOREIGN				0		
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0						
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0		
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES				0		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0		
3. CONSULTANT SERVICES				0		
4. COMPUTER SERVICES				0		
5. SUBAWARDS				0		
6. OTHER				6,000		
TOTAL OTHER DIRECT COSTS				6,000		
H. TOTAL DIRECT COSTS (A THROUGH G)				7,000		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Total direct (Rate: 50.5000, Base: 7000)						
TOTAL INDIRECT COSTS (F&A)				3,535		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				10,535		
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 10,535	$	
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $					
PI/PD NAME David L Dettman				FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* Julia Wood				Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION	FOR NSF USE ONLY		
University of Arizona	PROPOSAL NO.	DURATION (months)	
		Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR	AWARD NO.		
David L Dettman			

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. David L Dettman - none	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				0	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				0	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				0	
H. TOTAL DIRECT COSTS (A THROUGH G)				0	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)					
TOTAL INDIRECT COSTS (F&A)				0	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				0	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 0	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME	FOR NSF USE ONLY		
David L Dettman	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Julia Wood			

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0355217

SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION: University of Arizona				FOR NSF USE ONLY		
				PROPOSAL NO.	DURATION (months)	
					Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: David L Dettman				AWARD NO.		
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)	
1. David L Dettman - none	0.00	0.00	0.00	$ 0	$	
2.						
3.						
4.						
5.						
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0		
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0		
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0		
3. (0) GRADUATE STUDENTS				0		
4. (1) UNDERGRADUATE STUDENTS				1,250		
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0		
6. (0) OTHER				0		
TOTAL SALARIES AND WAGES (A + B)				1,250		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				59		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				1,309		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)						
TOTAL EQUIPMENT				0		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				1,000		
2. FOREIGN				0		
F. PARTICIPANT SUPPORT COSTS						
1. STIPENDS $ 0						
2. TRAVEL 0						
3. SUBSISTENCE 0						
4. OTHER 0						
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0		
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES				200		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0		
3. CONSULTANT SERVICES				0		
4. COMPUTER SERVICES				0		
5. SUBAWARDS				0		
6. OTHER				14,000		
TOTAL OTHER DIRECT COSTS				14,200		
H. TOTAL DIRECT COSTS (A THROUGH G)				16,509		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)						
TOTAL INDIRECT COSTS (F&A)				8,365		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				24,874		
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 24,874	$	
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $					
PI/PD NAME: David L Dettman				FOR NSF USE ONLY		
				INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*: Julia Wood				Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

BUDGET JUSTIFICATION

University of Arizona
David Dettman, PI

SALARY:

No salary is requested for Dettman.

Undergraduate hourly salary is requested in the first year to help with sample processing and mass spectrometer operation. This will contribute to our program of undergraduate experience in the stable isotope laboratory and will be associated with an undergraduate research project. $1250 in Year 1.

Undergraduate benefits and ERE are calculated at 4.7%.

TRAVEL:

$1000 is requested in Year 2 to assist Dettman in travel to meetings to report on results of the stable isotope component of this project.

MISC:

Supplies: Miscellaneous supplies for sample handling, chemicals, and data processing - $200 in Year 1.

Analytical costs: Carbonate samples for this project will be measured at a discounted rate of $10 per sample. We estimate that 1400 samples will be required based on the following: Although 19 cores will be collected and analyzed, there will be some that are lacking a continuous carbonate record in the interval of interest. Between 80 and 120 samples will be required in each core to document the environmental change at high resolution during this relatively short interval. Therefore we base our estimate on 100 samples per core and 14 cores being measured. Total = 1400 samples at $10 per sample. All analyses will be performed in the first two years, ~800 in Year 1 and ~ 600 in Year 2.

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION: **Kent State University**				FOR NSF USE ONLY — PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Alison J Smith**				AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Alison J Smith - PI	0.00	0.00	0.50	$ 4,060	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.50	4,060	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (1) UNDERGRADUATE STUDENTS				2,400	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				6,460	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				674	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				7,134	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				900	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				900	
H. TOTAL DIRECT COSTS (A THROUGH G)				8,034	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) MTDC (Rate: 44.5000, Base: 8034)					
TOTAL INDIRECT COSTS (F&A)				3,575	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				11,609	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 11,609	$

M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $		
PI/PD NAME: **Alison J Smith**	FOR NSF USE ONLY — INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*: **Charlee heimlich**	Date Checked	Date Of Rate Sheet	Initials - ORG

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 2

			FOR NSF USE ONLY		
ORGANIZATION			PROPOSAL NO.	DURATION (months)	
Kent State University				Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR			AWARD NO.		
Alison J Smith					

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Alison J Smith - PI**	0.00	0.00	0.50	$ 4,222	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.50	4,222	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (1) UNDERGRADUATE STUDENTS				2,400	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				6,622	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				700	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				7,322	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				900	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				900	
H. TOTAL DIRECT COSTS (A THROUGH G)				8,222	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 44.5000, Base: 8222)**					
TOTAL INDIRECT COSTS (F&A)				3,659	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				11,881	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 11,881	$

M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $		
PI/PD NAME	FOR NSF USE ONLY		
Alison J Smith	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Charlee heimlich			

2 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0354723

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY					
ORGANIZATION Kent State University	PROPOSAL NO.	DURATION (months) Proposed	Granted		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Alison J Smith	AWARD NO.				

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Alison J Smith - PI	0.00	0.00	0.50	$ 4,391	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.50	4,391	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (1) UNDERGRADUATE STUDENTS				2,400	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				6,791	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				727	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				7,518	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				800	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				800	
H. TOTAL DIRECT COSTS (A THROUGH G)				8,318	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) MTDC (Rate: 44.5000, Base: 8318)					
TOTAL INDIRECT COSTS (F&A)				3,702	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				12,020	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 12,020	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME Alison J Smith	FOR NSF USE ONLY		
	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* Charlee heimlich	Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0354723

SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION Kent State University				FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Alison J Smith				AWARD NO.		
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)	
1. Alison J Smith - PI	0.00	0.00	1.50	$ 12,673	$	
2.						
3.						
4.						
5.						
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0		
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	1.50	12,673		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0		
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0		
3. (0) GRADUATE STUDENTS				0		
4. (3) UNDERGRADUATE STUDENTS				7,200		
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0		
6. (0) OTHER				0		
TOTAL SALARIES AND WAGES (A + B)				19,873		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				2,101		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				21,974		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)						
TOTAL EQUIPMENT				0		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0		
2. FOREIGN				0		
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0						
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0		
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES				2,600		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0		
3. CONSULTANT SERVICES				0		
4. COMPUTER SERVICES				0		
5. SUBAWARDS				0		
6. OTHER				0		
TOTAL OTHER DIRECT COSTS				2,600		
H. TOTAL DIRECT COSTS (A THROUGH G)				24,574		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)						
TOTAL INDIRECT COSTS (F&A)				10,936		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				35,510		
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 35,510	$	
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $					
PI/PD NAME Alison J Smith				FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* Charlee heimlich				Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0354723

Kent State University Budget Justification

For Year 1,2 and 3
P.I.: ½ month summer salary: Support is requested for time commitment to this project outside the academic year. Salary for One half month each summer is requested.

Undergraduate Hourly Wage: Support is requested for hourly wage for undergraduate students who will work in the paleolimnology lab on the project samples. Students will learn how to process samples for micropaleontological examination.

Materials and Supplies: Funds are requested to cover the cost of expendable lab supplies needed to process and preserve the samples. These supplies typically include micropaleontological slides, whirlpac bags, beakers, vials, etc.

SUMMARY PROPOSAL BUDGET YEAR 1

ORGANIZATION University of Michigan Ann Arbor				FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed / Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR David K Rea				AWARD NO.	

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. David K Rea - Professor	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (1) GRADUATE STUDENTS				13,570	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				13,570	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				2,000	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				15,570	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				1,000	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				1,250	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				30,054	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				31,304	
H. TOTAL DIRECT COSTS (A THROUGH G)				47,874	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) 53% of first $25000 of subcontract (1-time charge) (Rate: 53.0000, Base: 25000) (Cont. on Comments Page)					
TOTAL INDIRECT COSTS (F&A)				22,695	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				70,569	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 70,569	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME David K Rea	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* Marvin parnes	Date Checked	Date Of Rate Sheet	Initials - ORG

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0355162

SUMMARY PROPOSAL BUDGET COMMENTS - Year 1

** I- Indirect Costs
53% of University of Michigan direct costs (Rate: 53.0000, Base 17820)

SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION University of Michigan Ann Arbor				FOR NSF USE ONLY		
				PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR David K Rea				AWARD NO.		
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)	
1. David K Rea - Professor	0.00	0.00	0.00	$ 0	$	
2.						
3.						
4.						
5.						
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0		
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0		
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0		
3. (1) GRADUATE STUDENTS				13,950		
4. (0) UNDERGRADUATE STUDENTS				0		
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0		
6. (0) OTHER				0		
TOTAL SALARIES AND WAGES (A + B)				13,950		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				2,000		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				15,950		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)						
TOTAL EQUIPMENT				0		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				1,500		
2. FOREIGN				0		
F. PARTICIPANT SUPPORT COSTS						
1. STIPENDS $ 0						
2. TRAVEL 0						
3. SUBSISTENCE 0						
4. OTHER 0						
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0		
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES				1,250		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0		
3. CONSULTANT SERVICES				0		
4. COMPUTER SERVICES				0		
5. SUBAWARDS				25,257		
6. OTHER				0		
TOTAL OTHER DIRECT COSTS				26,507		
H. TOTAL DIRECT COSTS (A THROUGH G)				43,957		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) 53% of University of Michigan direct costs (Rate: 53.0000, Base: 18700)						
TOTAL INDIRECT COSTS (F&A)				9,911		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				53,868		
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 53,868	$	
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $					
PI/PD NAME David K Rea				FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* Marvin parnes				Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0355162

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Michigan Ann Arbor

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
David K Rea

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. David K Rea - Professor	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				0	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				0	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				0	
H. TOTAL DIRECT COSTS (A THROUGH G)				0	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)					
TOTAL INDIRECT COSTS (F&A)				0	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				0	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 0	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME
David K Rea

ORG. REP. NAME*
Marvin parnes

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0355162

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Michigan Ann Arbor

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
David K Rea

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. David K Rea - Professor	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (2) GRADUATE STUDENTS				27,520	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				27,520	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				4,000	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				31,520	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				2,500	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				2,500	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				55,311	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				57,811	
H. TOTAL DIRECT COSTS (A THROUGH G)				91,831	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				32,606	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				124,437	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 124,437	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME
David K Rea

ORG. REP. NAME*
Marvin parnes

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

Notes to the University of Michigan budget:

Salaries and wages: PI Rea will oversee the work to be done at the University of Michigan at no cost to the project. Monies to support a graduate student on a research assistantship are requested. The student will have as a primary responsibility the grain size distribution analyses of the lacustrine sediments, along with other general sedimentology. Fringe benefits are at the amount called for in the university's contract with the Graduate Employees Organization (union). Tuition will be covered by a variety of sources as appropriate.

Laboratory supplies: These monies are for chemicals and supplies, primarily the electrolyte for the Coulter Counter and the many sample vials such projects engender.

Travel: Monies are requested for the student and PI to attend meetings and present the results of the work.

NOAA/GLERL subcontract: The hydrological modeling associated with this proposal will be conducted under the supervision of Dr. Thomas E. Croley at the Great Lakes Environmental Research Laboratory (GLERL) in Ann Arbor. Attached to these notes is Dr. Croley's work statement, and the GLERL budget. Note that GLERL contribution to the project totals more than the amount requested from NSF.

Statement of work by Dr. Croley, Great Lakes Environmental Research Laboratory:

Adapt the Great Lakes Advanced Hydrologic Prediction System (GLAHPS) to conditions in the 8.4-6.8 ka period by: 1) incorporating inferred or suggested paleo-topography and paleo-bathymetry of the Great Lakes into the GLAHPS, 2) incorporating suggested control point relations for lake/outlet behavior into the GLAHPS, 3) attempting to relate isotopic composition of precipitation and inflows to that of lake water, and 4) modifying, where pragmatic, GLAHPS model parameter values as suggested by paleo-geographic and paleo-hydrologic interpretations of the project geoscientists. Modify the historical meteorological record consistent with general (atmospheric) circulation model simulations of meteorology for 8.4-6.8 ka (depending upon availability of results) and/or with paleo-climate determinations of the project and with known insolation differences from the present. Explore Great Lakes hydrologic sensitivity/impacts with regard to altered climates by simulating with the adapted GLAHPS applied to the altered meteorologic scenarios. In particular, explore possible meteorology scenarios and their resulting (modeled) hydrologic scenarios with associated low water surfaces in the Huron, Michigan, and Erie basins that are compatible with geologic evidence for terminal lakes. Report at end of each calendar year. Participate in publications, presentations, and workshop.

Understanding Sensitivity of Great Lakes Water Levels to Climatic Forcing: Closed Lake Status 8.4-6.8KA (9400-7700 CAL)

GLERL budget for University of Michigan subcontract:

Item	Calendar Year 2004		Calendar Year 2005	
	NSF Funds Requested	GLERL Contribution	NSF Funds Requested	GLERL Contribution
Permanent Federal Staff				
Thomas E. Croley II, Res. Hydrol.		2mo. $22,083		1mo. $11,375
CILER Permanent Research Persons				
Janet Szczesny, Web Programmer	10% $4,056		10% $4,177	
CILER Temporary, Student				
Research Assoc. I, Computer Prog.	50% 12,400		50% 12,770	
Overheads	7,098	14,178	7,310	7,303
Travel	500			
Supplies	500		500	
Publications	500		500	
Vessel Costs	5000	7,500		
Totals	$30,054	$43,761	$25,257	$18,678

Deliverables:

1. Large Basin Runoff Model applied to Great Lakes watersheds, modified for paleo-application.
2. Estimates of Great Lakes sensitivity to high-amplitude climate change.
3. Reports at end of calendar years.
4. Participation in publications, presentations, and workshop.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: John W. King

Other agencies (including URITC) to which this proposal has been/will be submitted. None

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Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Assessment of Trends in Contaminant Inputs and Cultural Eutrophication in Cape Cod National Seashore and Acadia National Park, PI w/C. Roman (URI)

Source of Support: NAC-CESU, Dept. of Interior, NPS#1443CA4520-99-007

Total Award Amount: $89,942 Total Award Period Covered: 09/25/01 06/30/04

Location of Project: URI, Graduate School of Oceanography

Person-Months Per Year Committed to the Project. Cal: 0.5 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: COLLABORATIVE RESEARCH: Scientific Drilling in Lake Malawi, East African Rift, Co-PI w/T.C. Johnson (U. Minnesota-Duluth), et al.

Source of Support: NSF-ATM-0081165

Total Award Amount: $182,500 (URI) Total Award Period Covered: 02/01/02 01/31/04

Location of Project: URI, Graduate School of Oceanography

Person-Months Per Year Committed to the Project. Cal: 1.0 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Quonset Point/Davisville EIS Channel Characterization: Existing Data Review, Field Data Collection and Data Analysis Outline (Tasks 1 & 2), PI w/Co-PI E. Laliberte (URI)

Source of Support: Berger-Maguire Group #12A00241635A

Total Award Amount: $54,835 Total Award Period Covered: 05/13/02 05/13/04

Location of Project: URI, Graduate School of Oceanography

Person-Months Per Year Committed to the Project. Cal: 0.0 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Relationships Among Barrier Island Processes, Sea Level Rise, and Maintenance of Salt Marsh Habitat at Fire Island National Seashore, PI

Source of Support: NAC-CESU, Dept. of Interior, #1443CA452099007

Total Award Amount: $93,000 Total Award Period Covered: 07/18/02 12/30/03

Location of Project: URI, Graduate School of Oceanography

Person-Months Per Year Committed to the Project. Cal: 0.0 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: COLLABORATIVE RESEARCH: Understanding Sensitivity of Great Lakes Water Levels to Climatic Forcing: Closed Lake Status 8.4-6.8KA, 9400-7700 CAL BP, PI w/URI Co-PIs: K. Moran and M. Lewis (Visiting Scientist); D. Dettman (U. AZ); A. Smith (Kent State U.); D. Rea (U. Mich-Ann Arbor) THIS PROPOSAL

Source of Support: NSF-ATM (TPI#6208481)

Total Award Amount: $359,772 (URI prop) Total Award Period Covered: 12/01/03 11/30/06 (proposed)

Location of Project: URI, Graduate School of Oceanography

Person-Months Per Year Committed to the Project. Cal: 0.0 Acad: Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: C.F.Michael Lewis	Other agencies (including NSF) to which this proposal has been/will be submitted. None

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: COLLABORATIVE RESEARCH: Understanding Sensitivity of Great Lakes Water Levels to Climatic Forcing: Closed Lake Status 8.4-6.8KA, 9400-7700 CAL BP, Co-PI, Visiting Scientist, URI; w/J. King, PI and K. Moran, Co-PI, URI; D. Dettman (U. AZ); A. Smith (Kent State U.); D. Rea (U. Mich-Ann Arbor) THIS PROPOSAL

Source of Support: NSF-ATM (TPI#6208481)

Total Award Amount: $359,772 (URI prop) Total Award Period Covered: 12/01/03 11/30/06 (proposed)

Location of Project: URI, Graduate School of Oceanography

Person-Months Per Year Committed to the Project. Cal: 0.0 Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Kathryn Moran

Other agencies (including NSF) to which this proposal has been/will be submitted.
None

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: COLLABORATIVE RESEARCH: Understanding Sensitivity of Great Lakes Water Levels to Climatic Forcing: Closed Lake Status 8.4-6.8KA, 9400-7700 CAL BP, Co-PI w/ J. King (URI) and M. Lewis (Visiting Scientist); D. Dettman (U. AZ); A. Smith (Kent State U.); D. Rea (U. Mich-Ann Arbor) THIS PROPOSAL

Source of Support: NSF-ATM (TPI#6208481)

Total Award Amount: $359,772 (URI prop) Total Award Period Covered: 12/01/03 11/30/06 (proposed)

Location of Project: URI, Graduate School of Oceanography

Person-Months Per Year Committed to the Project. Cal: 0.0 Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **David Dettman**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Conservation Paleobiology**

Source of Support: **EAR-0125025**
Total Award Amount: $ **262,656** Total Award Period Covered: **01/01/02 - 12/31/04**
Location of Project: **Arizona**
Person-Months Per Year Committed to the Project. Cal: **1.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Collaborative Research: Scientific Drilling in Lake Malawi, East African Rift - Paleobiology Subcomponent**

Source of Support: **NSF - Earth System History**
Total Award Amount: $ **368,274** Total Award Period Covered: **08/01/02 - 07/31/06**
Location of Project: **Malawi**
Person-Months Per Year Committed to the Project. Cal: **0.50** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Collaborative Research: Understanding Sensitivity of Great Lakes Water Levels to Climatic Forcing: Closed Lake Status 8.4-6.8KA, 9400-7700 CAL**

Source of Support: **NSF-Paleoclimate**
Total Award Amount: $ **24,873** Total Award Period Covered: **12/01/03 - 11/30/06**
Location of Project: **Arizona**
Person-Months Per Year Committed to the Project. Cal: **1.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Alison Smith**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **(This proposal) Collaborative Research: Understanding Sensitivity of Great Lakes Water Levels to Climatic Forcing: Closed Lake Status 8.4-6.8 KA, 9400-7700 CAL**

Source of Support: **National Science Foundation**

Total Award Amount: $ **35,510** Total Award Period Covered: **12/01/03 - 11/30/06**

Location of Project: **Kent State University**

Person-Months Per Year Committed to the Project. Cal: **0.00** Acad: **1.13** Sumr: **0.50**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **David Rea**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Paleogene zonal winds of the Equatorial Pacific (Leg 199 post-cruise support)**

Source of Support: **Texas A&M Research Foundation**

Total Award Amount: $ **21,518** Total Award Period Covered: **12/01/01 - 10/31/04**

Location of Project: **Ann Arbor, MI**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Climate systems in transition: Winds and wind-driven circulation during the mid-Cenozoic cooling**

Source of Support: **NSF-OCE0136829**

Total Award Amount: $ **326,486** Total Award Period Covered: **06/01/02 - 05/31/05**

Location of Project: **Ann Arbor, MI**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **1.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Collaborative research: Site survey cruise for the South Pacific Latitudinal Transect: Paleoceanography of the Eocene sub-Antarctic Ocean.**

Source of Support: **NSF-OCE0240924**

Total Award Amount: $ **278,007** Total Award Period Covered: **08/01/03 - 07/31/06**

Location of Project: **Ann Arbor, MI; cruise to southwest Pacific**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.66** Sumr: **1.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **A physical record of the circumpolar circulation of the Southern Ocean - late Miocene to Pleistocene**

Source of Support: **NSF-OPP0337091**

Total Award Amount: $ **132,559** Total Award Period Covered: **01/01/00 - 01/01/00**

Location of Project: **Ann Arbor, MI**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Collaborative research: Understanding sensitivity of Great Lakes water levels to climatic forcing: Closed lake status 8.4-6.8 KA, 9400-7700 CAL**

Source of Support: **NSF-ATM (this proposal)**

Total Award Amount: $ **124,437** Total Award Period Covered: **01/01/00 - 01/01/00**

Location of Project: **Ann Arbor, MI**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Summ: **0.00**

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

PALEOMAGNETICS LABORATORY FACILITIES
Graduate School of Oceanography
University of Rhode Island

The Paleomagnetics Laboratory at the Graduate School of Oceanography, University of Rhode Island is one of the finest facilities for studies of sediments and rocks in the world. Short descriptions of the available facilities are listed below.

1. A 96 cubic meter transformer steel shielded room designed and built by Lodestar Magnetics and the Paleomagnetics Laboratory staff. Field values are less than 250 gammas.
2. Automated 2G 760R pass-through cryogenic rock magnetometer with a three-axis A.F. demagnetizer (Peak A.F. of 35 mT). The magnetometer has an automated sample track that can accommodate 3m long core segments with a maximum diameter of 11.4 cm and a cryocooler.
3. Automated 2G 755R U-channel Pass-through Cryogenic Rock Magnetometer with a three-axis A.F. demagnetizer (Peak A.F. .2T). Track can accommodate 3m of U-channel or 20 subsamples.
4. 2-Geotek Core Logging Systems: (1) whole core system with susceptibility, GRAPE and p-wave sensors; and (2) whole core/split core system with susceptibility, GRAPE, p-wave, and digital camera system
5. Molspin Minispin spinner magnetometer interfaced to a Columbia computer
6. D-Tech 200 mT A.F. Demagnetizer
7. Schonstedt TSD-1 Thermal Demagnetizer
8. A.S.C. Scientific Model I.M.-10-30 Impulse Magnetizer
9. Schonstedt DM-220 Digital Magnetometer
10. Bartington Susceptibility Meter Model M.S.2 with a variety of sensor types and sample-handling track.
11. Linux workstations with laser plotter and printer
12. Princeton Measurements Corp. MicroMag Model 2900 Alternating Gradient Force Magnetometer System capable of measurements to 2.0T
13. Cenco, 1.0T electromagnet
14. Elzone Model 180XY Particle-Size Analyzer with extra stand
15. Mackereth 6m corer plus accessories
16. Livingstone type corers, plus extension rods and casing
17. Pajari borehole monitoring device, rock drills and rock polishing equipment
18. Freeze corers (2m)
19. Variety of sediment traps, amplification funnels and release timer
20. Perkin-Elmer Model 4000 ZL Graphite Furnace Atomic Absorption Spectrometer
21. ETH-type piston corer, portable winch, wire, and A-frame; hydraulic power pack
22. 30’ Pontoon coring barge with 70 HP Johnson motor rigged to take 12m ETH-type piston cores

Facilities, Equipment and Other Resources

University of Arizona

The Department of Geosciences at the University of Arizona houses four stable isotope mass spectrometers. A Finnigan 252 mass spectrometer is solely dedicated to carbonate stable isotope analysis. A "Kiel III" automated preparation unit is attached to the 252 and allows the analysis of large numbers of very small samples (15micrograms). This system can be used to measure single or multiple ostracode valves as well as powdered samples from micromilling.

A VG 602 manual mass spec is used for Cl, N, and S isotopes. The Finnigan Delta-S Mass spectrometer is for general CO2 analysis and for measurement of the δD and $\delta^{18}O$ of waters (using automated preparation devices). A Finnigan Delta-Plus-XL is used for C, N, O, H, and S isotope analysis in organic materials and some minerals. Samples are automatically processed with attached EA, TC/EA and Gas bench units. The carbon isotope composition of dissolved inorganic carbon in water is analyzed using the Gasbench unit.

The University of Arizona also houses two micromilling units (one constructed as described in Dettman and Lohmann, 1995, and the other from Merchantek Corp.) used to separate carbonate samples along accretionary growth features. They have a practical minimum resolution of ~10 micrometers and an absolute resolution of 1 micrometer.

Petrographic, cathodoluminescence and scanning-electron microscopy facilities are available in the Geosciences at no charge for use in carbonate petrography. Standard limnological sediment sample separation and picking equipment (freezers, sieves, binocular microscopes) are also available.

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

Laboratory: **The Kent State University (KSU) Paleolimnology Lab in the KSU Geology Department is available for this project. The lab is equipped for washing, freezing, and freeze-drying sediment/microfossil samples, for reflected light and transmitted light microscopy, and microfossil sample**

Clinical:

Animal:

Computer: **2 Dell Optiplex GX150 Computers, 126 MB RAM in P.I.s office, available software includes MS Office, Deltagraph, Corel Photopaint & Draw, Paxit**

Office:

Other:

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

Virtis Freeze-Dryer - for sample processing Paleolimnology lab
Wild Microscopes - binocular transmitted/reflected light-Paleolim. lab
Freezers for sample processing
S.E.M. in Geology Department

OTHER RESOURCES: Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

access to department computer technician is available if needed

LABORATORY FACILITIES (continued):

storage.

Facilities at the University of Michigan Department of Geological Sciences

Oceanography Laboratory Complex:

The Oceanography Laboratory Complex contains sections devoted to marine geochemistry (R.M. Owen, supervisor), sedimentology (D.K. Rea, supervisor) and organic geochemistry (P.A. Meyers, supervisor). This Complex includes a sample preparation laboratory, sample storage room, and a data processing laboratory equipped with both PC and MAC desktop computers. The Marine Geochemistry Laboratory Is isolated from other parts of the Oceanography Laboratory Complex to insure a dust-free environment, and is equipped with a Perkin-Elmer Model 460 Atomic Absorption Spectrophotometer and Model HGA-2200 Graphite Furnace for elemental analyses and a Heath Model 701 Spectrophotometer. These instruments are routinely used for colorimetic analyses and for the analyses of metallic elements which cannot reliably be determined by INAA. Instrumentation for determining elemental abundances using inductively coupled plasma (ICP) techniques are also available within the department. The Marine Sedimentation Laboratory contains all the facilities necessary for routine analyses of marine and lacustrine sediments, and is equipped with a Coulter Multisizer-3 for precise grainsize analyses. The Organic Geochemistry Laboratory is set up to conduct GC/MS analyses of the organic fraction of sediments and rocks. A Carlo-Erba CHNS-O analyzer is in this laboratory, along with its attached computer.

Biographical Sketch: STEVE M. BLASCO C.M., B.Sc. (Eng), P.Eng.

Marine Environmental Geoscience Subdivision
Geological Survey of Canada (Atlantic)
Bedford Institute of Oceanography,
P. O. Box 1006,
Dartmouth NS B2Y 4A2

Telephone 902-426-3932
Fax 902-426-4104
Email sblasco@nrcan.gc.ca

Education Honours B.Sc. (Eng): Engineering Geophysics: 1972,
Queen's University,
Kingston, Ontario, Canada

Employment / Professional Recognition

1976-Present: Resource Engineering Geophysicist
Geological Survey of Canada Atlantic
Natural Resources Canada

1. Physical Scientist: Leader, Great Lakes lakebed geology project 1997-present)
2. Physical Scientist: Leader, Beaufort Shelf Quaternary geology project (1977-present)

Awards

2001: Governor General s appointment: Member of the Order of Canada (Science) C.M.
1996: Queen s University: Herbert J. Hamilton Award for exceptional service to the university alumni association
1987: Distinguished Merit Award from the Government of Canada for leadership in conducting geological and engineering investigations in the Beaufort Sea.

Selected Publications

Blasco, S.M. 2001. Geological history of Fathom Five National Marine Park over the past 15000 years. *In* S. Parker and M. Munawar (eds) Ecology, Culture and Conservation of a Protected Area: Fathom Five National Marine Park, Lake Huron, Canada. Ecovision Monograph Series, Brackhuys Publishing, p. 45-62.

Blasco, S., Travaglini, P., Covill, B., Calhoun, J., and Promaine, A. 2001. 3-D underwater mapping: submerged Niagara Escarpment of Fathom Five National Marine Park in a new light. Leading Edge Conference 01, Niagara Escarpment and Long Point, October 16-18, 2001, Burlington, Ontario, Program with Abstracts, Niagara Escarpment Commission publication, Georgetown, Ontario, poster.

Blasco, S.M., Lewis, C.F.M., McCarthy, F. and Sardis, A. 2001. Evidence for Climate Driven Low Lake Levels in the Georgian Bay Basin at 7600 BP. 44th International Conference on Great Lakes Science, June 10-14, 2001, Green Bay, Wisconsin, USA. International Association for Great Lakes Research, program with abstracts.

Blasco, S.M., Janusas, S.E., McClellan, S. and Amos, A. 1997.Prehistoric drainage across the submerged Niagara Escarpment north of Tobermory. Leading Edge Conference 97, Niagara Escarpment and Long Point, October 16-18, 1997, Burlington, Ontario, Conference Proceedings, Niagara Escarpment Commission publication, Georgetown, Ontario, pp. 218-225**.**

Blasco, S.M. and Lewis, C.F.M. 1996. Evidence of neotectonic activity in the Georgian Bay Linear Zone, southern Ontario, GSA Northeastern Section Mtg, Abstracts with Programs, Buffalo, N. Y., March 21-23, 1996, p 40.

Blasco, S.M., Harmes, R.A., Harrison, P.H.., and Keyes, D.L. 1996. Evidence of neotectonic activity, Georgian Bay lake basin, southern Ontario, GAC joint annual meeting, Program with Abstracts, Winnipeg, Manitoba, March 27-29, 1996 p. A9.

Lewis, C.F.M. and Blasco, S.M. 2001. Evidence for Late Wisconsinan High Velocity Glaciofluvial Flushing followed by early Holocene low lake levels and closed basin conditions in the lower Great Lakes. 44th International Conference on Great Lakes Science, June 10-14, 2001, Green Bay, Wisconsin, USA. International Association for Great Lakes Research, program with abstracts.

C.F.M. Lewis, S.M. Blasco and P.L. Gareau. 2001, Newly discovered evidence for mid-early Holocene climate induced low water levels in the Great Lakes. Canadian Climate Impacts and Adaptation Research Network Coastal Zone Workshop, March 5-6, 2001, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, poster sb2125.

Lewis, C.F.M., Cameron, G.D.M., King, E.L., Todd, B.J. and Blasco, S.M. 1995. Structural contour, isopach and features maps of Quaternary sediments in Western Lake Ontario. Atomic Energy Control Board of Ontario public document: AECB project 2.243.1, June, 67p, 46 figs, 2 tables, 12 maps.

Biographical Sketch: JOHN P. COAKLEY

23 Lower Horning Road
Hamilton, Ontario, L8S 3E9 Canada
Telephone: (905) 527-5219 (Res.); (905) 336-4881 (CCIW)
Fax: (905) 336-4400; E-mail: john.coakley@cciw.ca

ACADEMIC BACKGROUND

Ph.D. (Quaternary Geology) - University of Waterloo, Canada
Thesis topic: Quaternary geology and sediment history of Lake Erie
M.Sc. (Sedimentary Geology) - University of Ottawa, Canada
B.Sc. (Geology) - St. Francis Xavier University, Canada

Employment History

1965-1967	Master s Student and Technical Assistant at Geological Survey of Canada, Quaternary Section
1967-1973	Physical Sciences, Environment Canada, Canada Centre for Inland Waters
1973-2001	Research Scientist, Environment Canada, National Waater Research Institute, CCIW
2001-present	Emeritus Scientist, NWRI/CCIW

Research Interests

- Dynamic sediment processes in the coastal zone of large lakes and estuaries aimed at quantifying the transport and depositional fate of priority contaminants.
- Long-term natural evolution of Great Lakes shorelines and coastal landforms on the basis of sediment, morphologic, and lake process evidence.
- Water management plans and sediment remediation

Professional and academic offices held:

Board of Directors, International Association for Great Lakes Research (2000-)
Member, Estuarine Research Federation Education Committee (1992-1996)
Member, Water Management Advisory Board, Hamilton Region Conservation Authority (1980-1992)
Assoc. Editor, International Association for Sediment - Water Science, 1990
Member, Ecosystem Integrity Working Group, Hamilton / Wentworth Task Force on Sustainable Development (1995 -)
Member, Sediment Sub-Committee, International Joint Commission (1984-1990)
Member, IAGLR Chandler-Meisner Award Committee, 1995
Assoc. member, Faculty of Graduate Studies, University of Guelph (1995 -)
External Graduate student research examiner:
- Ed Harvey (M.Sc) University of Waterloo
- Tonny Bachtiar (M.Sc) McMaster University
- Tania Poehlman (M.Sc) University of Guelph
- Rebecca Kempthorne (M.Sc) University of Akron

University courses and lectures:
- Guest lecturer, University of Guelph, in Organic Carbon and Fuels course, topic: "Giant Oil Fields"
- Guest lecturer, Guelph, in course on tropical coastal ecosystems, topic: "Geology and landform evolution of the Bahamas"

- Replacement lecturer, Guelph, for course, "Glacial and Quaternary Geology"
- Invited Speaker: Symposium on the Red Sea Marine Environment , Jeddah, Saudi Arabia, Nov. 1999

Professional Societies:

International Association of Sedimentologists
Geological Association of Canada
Association of Professional Engineers of Ontario
Estuarine Research Federation
Aquatic Ecosystem Health and Management Society
Association of Geoscientists for International Development
Canadian Quaternary Research Association
Association Quebe oise pour l' tude du Quaternaire

LIST OF SELECTED PUBLICATIONS* - Dr. J.P. COAKLEY, P.Eng.

* Dr. Coakley is the author or co-author of over 70 scientific publications and more than 90 oral presentations (a complete list is available on request).

Rust, B.R.; and **COAKLEY, J.P.**, 1970. Physico-chemical characteristics and postglacial desalination of Stanwell-Fletcher Lake, Arctic Canada. Can. Jour. Earth Sciences, 7 (3): 900-911.

COAKLEY, J.P., 1976. The formation and evolution of Point Pelee, western Lake Erie. Can. Jour. Earth Sciences 13 (1): 136-144.

COAKLEY J.P., 1985. Evolution of Lake Erie based on the postglacial sedimentary record below the Long Point, Point Pelee and Pointe-aux-Pins forelands. Unpubl. Ph.D. Thesis, Dept. Earth Sciences, Univ. of Waterloo, 362 pages.

COAKLEY J.P., and Lewis C.F.M., 1985. Postglacial lake levels in the Erie Basin. In: Quaternary Evolution of the Great Lakes, P.F. Karrow and P. Calkin, Eds.; Geol. Assoc. Canada, Special Paper 30, pp. 195-212.

COAKLEY, J.P., 1989. The origin and evolution of a complex cuspate foreland: Pointe-aux-Pins, Lake Erie. G ographie Physique et Quaternaire, vol. 43 (1): 65-76.

COAKLEY, J.P.; and Poulton, D.J. 1991. Tracing long-term fine sediment transport in Humber Bay, Lake Ontario. Jour. Great Lakes Res. 17 (3): 289-303.

COAKLEY, J.P., 1992. Holocene transgression and coastal landform evolution in northeastern Lake Erie, Canada. In: Quaternary Coasts of the United States: Marine and Lacustrine Systems, Fletcher, C.H. and Wehmiller, J.F. (eds.); American Society of Economic Paleontologists and Mineralogists (SEPM) Special Publication 48 : 415-426.

COAKLEY, J.P; Carey, J.H.; and Eadie, B.J. 1992. Specific organic components as tracers of contaminated fine sediment dispersal in Lake Ontario near Toronto. Hydrobiologia 235/236: 85-96.

COAKLEY, J.P. and Poulton, D.J. 1993. Source-related classification of St. Lawrence estuary sediments. Estuaries 16 (4): 873-886.

COAKLEY, J.P. and Karrow, P.F. 1994. Reconstruction of post-Iroquois shoreline evolution in western Lake Ontario. Can. Jour. Earth Sci. 31: 1618-1629.

Bachtiar, T.; **COAKLEY, J.P.**, and Risk, M. 1996. Tracing sewage-contaminated sediments in Hamilton Harbour using selected geochemical indicators. Sci. Total Environ. 179: 3-16.

COAKLEY, J.P. and Mudroch, A. 1996. Contaminated sediments in urban environments: sources, transport, and fate. In: Environmental Geology of Urban Areas (N. Eyles, Ed.), Geoscience Canada pp. 227-239.

Tevesz, M.J.S.; Smith, J.E.; **COAKLEY, J.P**.; and Risk, M.J. 1997. Stable isotope records (C and O) from Lake Erie sediment cores: mollusk aragonite 3500 BP - 500 BP. NWRI Contrib. 96-92. Jour. Great Lakes Res. 23 (3): 307-316.

Lewis, C.F.M, Mayer, L.A., Mukhopadyay, P.K., Kruge, M.A., **COAKLEY, J.P**., and Smith, M.D., 1999. Multibeam sonar backscatter lineaments and anthropogenic organic components in lacustrine silty clay, evidence of shipping in western Lake Ontario. Internat. Journal of Coal Geology, 43(2000): 307-324. NWRI Contrib, 99-205.

COAKLEY, J.P. and Lewis, C.F.M. 2000 (In press). Sedimentary Environment of Lake Ontario: Geologic Setting, Sediment Processes, and Environmental Hazards. In: The State of Lake Ontario , M. Munawar (Ed.). NWRI Contrib. 99-257

Biographical Sketch: THOMAS EARL CROLEY II

I. Education

B.C.E.. 1969 (Civil Engineering)
Ohio State University

M.S. 1970 (Civil Engineering, Hydrology)
Ohio State University

Ph.D. 1972 (Civil Engineering, Stochastic Hydrology)
Colorado State University

Employment

08/72-08/76 Assist. Prof. & Res. Eng., Univ. of Iowa, Iowa Inst. of Hydrau. Res.
09/76-12/80 Assoc. Prof. & Res. Eng., Univ. of Iowa, Iowa Inst. of Hydrau. Res.
(03/79-03/80 Visit. Prof., Univ. Canterbury, Lincoln College, New Zealand)
01/81-present Research Hydrologist, Great Lakes Environ. Research Laboratory
(06-08/90 Visit. Scien., Soviet Geophysical Comm., Moscow, USSR)

I. Research Interests

Hydrology, Large Basin Runoff Modeling, Water Resources Forecasting, Operational Hydrology, Watershed and Lake Thermodynamics Modeling, Computer Science

II. Professional Service

1996-present Associate Editor, *Journal of Hydrologic Engineering*, ASCE
2001-present US Board Member, International Coordinating Committee on Great Lakes Hydraulic and Hydrologic Data (Hydrol. Subcom. 1993-present)
2000-present US Co-chairman, IJC Lake Ontario-St. Lawrence Regulation Study Working Group on Hydrology and Hydraulics Models
2000-present Member, ASCE Task Committee on Climate Variations, Climate Change and Water Resources Engineering

III. Professional Affiliations

American Institute of Hydrology, American Geophysical Union

IV. Publications

Recent Publications:

Croley, T. E., II, 2002. Large basin runoff model. *Mathematical Models in Watershed Hydrology, Vol. 1,* Chapter 17, (V. Singh, D. Frevert, and S. Meyer, Eds.), Water Resources Publications, Littleton, Colorado, 717-768 (in press).

Croley, T. E., II, 2001. Climate-Biased Storm-Frequency Estimation. *J. Hydrol. Eng.*, **6**(4):275-283.

Croley, T. E., II, 2000. *Using Meteorology Probability Forecasts in Operational Hydrology*. ASCE Press, American Society of Civil Engineers, Reston, Virginia, 214 pp.

Quinn, F. H., T. E. Croley II, 1999. Potential climate change impacts on Lake Erie. In *State of Lake Erie (SOLE) Past, Present and Future* (M. Munawar, Ed.), Ecovision World Monograph Series, Backhuys, Leiden, The Netherlands, 23-30.

Schertzer, W. M., T. E. Croley II, 1999. Climate and lake responses, Chapter 2, *Potential Climate Change Effects on Great Lakes Hydrodynamics and Water Quality,* ASCE Task Committee on Climatic Effects on Lake Hydrodynamics, (Lamb, Schertzer, Eds.), ASCE, New York, 2-1 2-74.

Publications Appropriate to This Proposal

Croley, T. E., II, F. H. Quinn, K. E., Kunkel, and S. J. Changnon, 1998. Great Lakes hydrology under transposed climates, *Climatic Change*, **38**:405-433.

Quinn, F. H., T. E. Croley II, K. E. Kunkel, and S. J. Changnon, 1997. Laurentian Great Lakes hydrology and lake levels under the transposed 1993 Mississippi River flood climate, *Journal of Great Lakes Research*, IAGLR, 23(3):317-327.

Croley, T. E., II, 1995. Laurentian Great Lakes dynamics, climate, and response to change. Chapter 9 in *The Role of Water and the Hydrological Cycle in Global Change* (H.R. Oliver and S. A. Oliver, Eds.), NATO Advanced Science Institutes Series 1: Global Environmental Change, Vol. 31, Springer-Verlag, Berlin, 253-296.

Croley, T. E., II, 1994. Hydrological impacts of climate change on the Laurentian Great Lakes, *Trends In Hydrology*, Council of Scientific Research Integration, Research Trends, Kaithamukku, Trivandrum, India, **1**:1-25.

Croley, T. E., II, 1990. Laurentian Great Lakes double-CO_2 climate change hydrological impacts, *Climatic Change*, Kluwer Academic Publishers, **17**:27-47.

V. Graduate Students/Post-Doctoral Scholars Advised

Graduate Students

1. Committee Chairman for 13 M.Sc students at University of Iowa
2. Committee member of 11 additional M.Sc students at University of Iowa
3. Committee Chairman for 10 Ph.D. students at University of Iowa
4. Committee member of 2 additional Ph.D. students at University of Iowa
5. Committee member of 2 Ph.D. students at University of Michigan

Post-Doctoral Scholars

1. Karl Schneider, 1993
2. Yongchun Zhu, 1999
3. Changshen He, 2002

VI. List of Collaborators and Long-term Associates

1. Dr. F. H. Quinn, GLERL
2. Mr. R. A. Assel, GLERL
3. Ms. C L. Luukkonen, USGS
4. Ms. D. H. Lee, USACE
5. Dr. G. R. Foster, USDA
6. Dr. S. J. Changnon, Illinois State Water Survey
7. Dr. K. E. Kunkel, Midwestern Climate Center
8. Mr. W. M. Schertzer, Canada Centre for Inland Waters
9. Dr. V. Privalsky, Soviet Geophysical Committee, USSR Academy of Sciences

Biographical Sketch: T. W. D. EDWARDS

Professor, Department of Earth Sciences
University of Waterloo
200 University Avenue West
Waterloo ON

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Fax 519 746 0183
Email twdedwar@sciborg.uwaterloo.ca

Education B.Sc. Geological Sciences, Queen s University,1977
M.Sc Geological Sciences, Queen s University,1980
Ph.D. Earth Sciences, University of Waterloo, 1987

Employment / Professional Recognition

University of Waterloo, Earth Sciences 1988 - present
Assistant Professor 1988 - 1994
Associate Professor 1994 - 1999
Visiting Scientist, GSF-Neuherberg, Germany, 1994 - 1995 and 1998
Professor 1999 - present

Selected Publications

Gibson, **J.J. and Edwards, T.W.D.** in press. Regional surface water balance and evaporation-transpiration partitioning from a stable isotope survey of lakes in northern Canada. Global Biogeochemical Cycles.

Wolfe, B.B., Edwards, T.W.D., Beuning, K.R.M., and Elgood, R.J. in press. Carbon and Oxygen Isotope Analysis of Lake sedimnet cellulose: Methods and Applications. In Tracking environmental Change using Lake sediments: Physical and chemical techniques. Edited by Last, W.M. and Smol, J.P. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Birks, S.J., Remenda, V.H. and Edwards, T.W.D. 2000. Clay aquitards as isotopic archives of holocene paleoclimate in the northern Great Plains: Sensitivity analysis. Hydrological processes 14, 1523-1536.

Wolfe, B.B., Edwards, T.W.D., Aravena, R., Forman, S.L., Warner, B.G., Velichko, A.A. and MacDonald, G.M. 2000. Holocene paleohydrology and paleoclimate at treeline, north-central Russia, inferred from oxygen isotope records in lake sediment cellulose. Quaternary research 53, 319-329.

Edwards, T.W.D., Graf. W., Trimborn, P., Stichler, W., Lipp, J. and Payer, H.D. 2000. $d^{13}C$ response surface resolves humidity and temperature signals in trees. Geochimica et Cosmochimica Acta 64, 161-167.

Wolfe, B.B., Edwards, T.W.D. and Duthie, H.C. 2000. A 6000-year record of interaction between Hamilton Harbour and Lake Ontario: quantitative assessment of recent disturbance using ^{13}C in lake sediment cellulose. Aquatic Ecosystem Health and

Management 3, 47-54.
Wolfe, B.B., Edwards, T.W.D. and Aravena, R. 1999. Changes in carbon and nitrogen cycling during treeline retreat recorded in the isotopic content of lacustrine organic matter, western Taimyr Peninsula, Russia. The Holocene 9, 215-222.
Wolfe, B.B. and Edwards, T.W.D. 1998. Comment on Stable carbon and oxygen isotopes records from Lake Erie sediment cores: mollusc aragonite 4600 BP-200 BP (J. Great Lakes Research 23, 307-316). Journal of Great Lakes Research 24, 736-738.
Wolfe, B.B. and Edwards, T.W.D. 1997. Hydrologic control on the oxygen-isotope relation between sediment cellulose and lake water, Taimyr Peninsula, Russia: Implications for the use of surface-sediment calibrations in paleolimnology. Journal of Paleolimnology 18, 283-291.
Motz, J.E., Edwards, T.W.D. and Buhay, W.M. 1997. Use of nickel-tube pyrolysis for hydrogen-isotope analysis of water and other compounds. Chemical Geology 140, 145-149.
Wolfe, B.B., Edwards, T.W.D., Aravena, R. and MacDonald, G.M. 1996. Rapid Holocene hydrologic change along boreal treeline revealed by $d^{13}C$ and $d^{18}O$ in organic lake sediments, Northwest Territories, Canada. Journal of Paleolimnology 15, 171-181.
Edwards, T.W.D. and Luckman, B.H. 1996. Isotope dendroclimatology studies in the Canadian Rockies: some preliminary results. Environment and Humanity. Edited by Dean, J.S., Meko, D.M. and Swetnam, T.W. Radiocarbon, 585-596.
Lipp, J., Trimborn, P., Edwards, T.W.D., Graf, W. and Becker, B. 1996. Climate signals in a ^{2}H and ^{13}C chronology (1882-1989) from tree rings of spruce (*Picea abies* L.). Environment and Humanity. Edited by Dean, J.S., Meko, D.M. and Swetnam, T.W. Radiocarbon, 603-610.
Duthie, H.C., Yang, J.-R., Edwards, T.W.D., Wolfe, B.B. and Warner, B.G. 1996. Hamilton Harbour, Ontario: 8300 years of limnological and environmental change inferred from microfossil and isotopic analyses. Journal of Paleolimnology 15, 79-97.
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Biographical Sketch: KATHLEEN RUTH LAIRD

Paleoecological Environmental Assessment and Research Laboratory
Queen's University, Kingston, Ontario K7L 3N6
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Education

1996 Ph.D. in Ecology, University of Minnesota, Minneapolis, Minnesota. Dr. H.E. Wright and Dr. S.C. Fritz, advisors.

1989 B.Sc., University of Massachusetts, North Dartmouth. Major: Biology with emphasis in Marine Biology. Graduated Summa Cum Laude.

Professional Experience

2002-present Research Associate, Queen s University

1999-2002 Natural Sciences and Engineering Research Council of Canada (NSERC) Postdoctoral Fellowship, Queen s University (includes 1 year maternity leave)

1996-1999 Postdoctoral Researcher, Queen's University.

1996-1999 Co-Secretary/Treasurer Society of Canadian Limnologists

1994-1996 Research Fellowship — National Science Foundation (NSF) Grant.

1993-1994 Teaching Assistant, General Biology, University of Minnesota.

1992-1993 Research Assistant, supervisor S.C. Fritz, University of Minnesota.

1990-1992 Research Fellowship, Dept. of Ecology, Evolution and Behavioural Biology, University of Minnesota.

1989-1990 Teaching Assistant, General Ecology and Biology of Fish, University of Massachusetts, North Dartmouth.

1990 Algal Ecologist. Environmental Water Resource Division of Army Corps of Engineers, Massachusetts Division (summer).

1989 Biological Technician. National Marine Fisheries Service, Woods Hole, Massachusetts (summer).

1988 Technician. Darling Marine Center, U. of Maine marine laboratory, Walpole, ME (summer).

Publications

Publications Appropriate to This Proposal

LAIRD, K.R., B.F. Cumming, S. Wunsam, J. Rusak, R.J. Oglesby, S.C. Fritz and P.R. Leavitt (2003). Large-scale shifts in moisture regimes from lake records across the northern prairies of North America during the past two millennia. *Proceedings of National Academy Science* 100: 2483-2488..

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LAIRD, K.R., S.C. Fritz, K.A. Maasch and B.F. Cumming (1996). Greater drought intensity and frequency before AD 1200 in the Northern Great Plains, USA. *Nature* 384:552-554.

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Biographical Sketch: KATHLEEN RUTH LAIRD

Recent Publications

Bradbury, J.P., B.F. Cumming and K.R. LAIRD (2002). A 1500-year record of climatic and environmental change in Elk Lake, Minnesota III: measures of past primary productivity. *Journal of Paleolimnology* 27: 321-340.

Fritz, S.C., E. Ito, Z. Yu, K.R. LAIRD and D.R. Engstrom (2000). Hydrologic variation in the Northern Great Plains during the last two millennia. *Quaternary Research* 53: 175-184.

Fritz, S.C., B.F. Cumming, F. Gasse and K.R. LAIRD (1999). Diatoms as indicators of hydrologic and climatic change in saline lakes. In Diatoms: Applications to the Environmental and Earth Sciences (Chapter 4). E. Stoermer and J.P. Smol, eds. Cambridge University Press, pp. 41-72.LAIRD, K.R., S.C. Fritz and B.F. Cumming (1998). Early-Holocene limnological and climatic variability in the Northern Great Plains. *The Holocene* 8: 275-286.

LAIRD, K.R., S.C. Fritz, E.C. Grimm and P. G. Mueller. (1996). Century-scale paleoclimatic reconstruction from Moon Lake, a closed-basin lake in the northern Great Plains. *Limnology and Oceanography* 41: 890-902.

Biographical Sketch: JOHN H. McANDREWS

Departments of Botany and Geology, University of Toronto
25 Wilcocks St., Toronto, Ontario, Canada M5S 3B2
416 978 6940 jock.mcandrews@utoronto.ca

Education

B.Sc. (Biology) University of St. Thomas (1957)
M.Sc. (Botany) University of Minnesota (1959)
Ph.D. (Botany) University of Minnesota (1964)

Employment

1967-1996	curator, Royal Ontario Museum
1968-1998	professor, University of Toronto
1996-	Curator emeritus
1998-	Professor emeritus

Recent Publications

Karrow, P.F., J.H. McAndrews, B.B. Miller, A.V. Morgan, K.L. Seymour and O.L. White. 2001. Illinoisian to Late Wisconsinan stratigraphy at Woodbridge, Ontario. Canadian Journal of Earth Sciences 38:921-942.
Jackson, L.J., C. Ellis, A.V. Morgan and J.H. McAndrews. 2000. Glacial Lake levels and eastern Great Lakes Palaeoindians. Geoarchaeology 15:415-440.
St. Jaques, J.M., M.S.V. Douglas and J.H. McAndrews. 2000. Mid-Holocene hemlock decline and diatom communities in van Nostrand Lake, Ontario, Canada. Journal of Paleolimnology 23:385-397.
Campbell, I.D., W.M. Last, C. Campbell, S. Clare and J.H. McAndrews. 2000. The late-Holocene paleohydrology of Pine Lake, Alberta: a comparison of proxy types. Journal of Paleolimnology 24:427-441.
Morgan, A.V., J.H. McAndrews and C. Ellis. 2000. Geological history and paleoenvironment. In: C. Ellis and D.B. Deller. (editors). An early paleoindian site near Parkhill, Ontario. Mercury Series, Archaeological Survey of Canada Paper 159. Canadian Museum of Civilizaton. Chapter 2, pages 9-30.

Publications Appropriate to This Proposal

Haas, J.N. and J.H. McAndrews. 2000. The summer drought related hemlock (*Tsuga canadensis*) decline in eastern North America 5,700 to 5,100 years ago. In McManus, K.A., K.S. Shields and D.R. Souto (editors). 2000. Pages 81-88. Proceedings: Symposium on sustainable management of hemlock ecosystems in eastern North America. General Technical report 267. USDA Forest Service, Northeastern Research Station. 237 pages.
Yu, Z., J.H. McAndrews and U. Eicher. 1997. Middle Holocene dry climate caused by change in atmospheric circulation patterns: evidence from lake levels and stable isotopes. Geology 25:251-254.

McAndrews, J.H. and I.D. Campbell. 1993. 6ka mean July temperature in eastern Canada from Bartlein and Webb's (1985) pollen transfer functions: comments and illustrations. In A. Telka, compiler. Proxy Climate Data and Models of the Six Thousand Years Before Present Time Interval: The Canadian Perspective. Canadian Global Change Program, Incidental Report Series No. IR93-3. pp. 22-25.

McCarthy, F.M.G. and J.H. McAndrews. 1988. Water levels in Lake Ontario 4,230-2,000 years B.P.: evidence from Grenadier Pond, Toronto, Canada. Journal of Paleolimnology 1:99-113.

McAndrews, J.H. 1981. Late Quaternary climate of Ontario: temperature trends from the fossil pollen record. In: W.C. Mahaney (Ed). Quaternary Paleoclimate. Geo Abstracts. pp. 319-333.

Biographical Sketch: FRANCINE MARIE GISELE McCARTHY

I. **Education**

B.Sc. 1984 (Geology and Biology), Dalhousie University
M.Sc.1986 (Geology), University of Toronto
Ph.D. 1992 (Earth Science) Dalhousie University

Employment

1990-1991	Lecturer (Sabbatical Replacement),Geology, St. Francis Xavier University
1991-1992	Lecturer (Tenure-track appointment), Earth Sciences, Brock University
1992-1996	Assistant Professor, Earth Sciences, Brock University
1998-2000	Director, Environmental Sciences, Brock University
1996-2002	Associate Professor, Earth Sciences, Brock University
2001-present	Director, Liberal Studies, Brock University
2002-present	Professor, Earth Sciences, Brock University

Research Interests: Micropaleontology, palynology, taphonomy, paleoclimatology, marine geology, paleolimnology, sedimentation, lake- and sea-level change, sequence stratigraphy

II. **Professional Service**

- Secretary-Treasurer, Canadian Association of Palynologists, 1997-2001
- Board Member, American Association of Stratigraphic Palynologists, 2003-present

III. **Professional Affiliations**

American Geophysical Union (AGU)
Society of Economic Paleontologists and Mineralogists (SEPM)
Canadian Association of Palynologists (CAP)
American Association of Stratigraphic Palynologists (AASP)
Paleontological Society (PS)
Cushman Foundation for Foraminiferal Research

IV. **Publications**

Recent Publications:

McCarthy, F. M.G., Gostlin, K.E.,Mudie, P.J., and Ohlenschlager Pedersen, R., in .Palynological studies of terrigenous flux to the deep sea: two examples from 41o N latitude. Accepted for a special volume of Review of Paleobotany and Palynology November 20, 2002.

McCarthy, F.M.G., Gostlin, K.E., Mudie, P.J., and Hopkins, J., 2003. Terrestrial and marine palynomorphs as sea-level proxies: an example from Quaternary sediments on the New Jersey margin, in Olson, H.C. and Leckie, M. (Eds.) "Micropaleontologic Proxies for Sea-Level Change and Stratigraphic Discontinuities", SEPM SpecialPublication No. 75, p. 119-129.

Hopkins, J.A. and McCarthy, F.M.G., 2002. Postdepositional palynomorph degradation in Quaternary shelf sediments:a laboratory experiment studying the effects of progressive oxidation.Palynology, v. 26.

Savrda, C.E., Krawinkle, H., McCarthy, F.M.G., McHugh, C., Olson, H.C., and Mountain, G., 2001. Ichnofacies of a Pleistocene slope sequence, New Jersey Margin: relations to climate and sea-level dynamics. Palaeogeography, Palaeoclimatology, Palaeoecology v. 171, p. 41-61.

McCarthy, F.M.G. and Gostlin, K.E., 2000. Correlating Pleistocene sequences across the New Jersey margin. Sedimentary Geology, v. 134, p. 181-196.

Publications Appropriate to This Proposal

Sarvis, A.P., McCarthy, F.M.G., Blasco, S.,Tiffin, S.H., and Gostlin, K.E. (1999), Explaining the lowstand in Georgian Bay approximately 7,200 years ago: a paleolimnological approach using microfossil evidence. Leading Edge 99, Burlington, Ont.,Oct. 6-8,1999, CD-ROM.

Pengelly, .W., Tinkler, K.J., Parkins, W.G., and McCarthy, F.M.G., 1997. 12,600 years of lake level changes, changing sills, ephemeral lakes, and Niagara Gorge erosion in the Niagara Peninsula and eastern Lake Erie Basin. Journal of Paleolimnology, v. 17, p. 377-402

McCarthy, F.M.G., Collins, E.S., McAndrews, J.H., Kerr, H.A., Scott, D.B., and Medioli, F.S. 1995. A comparison of postglacial arcellacean ("thecamoebian") and pollen succession in Atlantic Canada, illustrating the potential of arcellaceans for paleoclimatic reconstruction. Journal of Paleontology, v. 69 (5), p. 980-993.

Collins, E.S., McCarthy, F.M.G., Medioli, F.S.,Scott, D.B., and Honig, C.A., 1990. Biogeographic distribution of modern thecamoebians in a transect along the eastern North American coast. In Hemleben, C., Kaminski, M.A., Kuhnt, W., and Scott, D.B. (eds.) Paleoecology, Biostratigraphy, Paleoceanography and Taxonomy of Agglutinated Foraminifera, International Workshop on Agglutinated Foraminifera III, Tubingen, Germany, 1989, Kluwer Academic Publishers, p.783-792.

McCarthy, F.M.G. and McAndrews, J.H., 1988. Water levels in Lake Ontario 4230-2000 years B.P.: evidence from Grenadier Pond, Toronto, Canada. Journal of Paleolimnology, v. 1, p. 99-113.

V. Graduate Students Advised

1. Mr. Kevin E. Gostlin, MSc, 1999
2. Mr. Adam P. Sarvis, MSc, 2001
3. Ms. Sarah H. Tiffin, MSc, 2001
4. Ms. Jennifer A. Hopkins, MSc In Progress
5. Mr. Duncan J. Findlay, MSc In Progress
6. Mr. Martin L. Little, MSc In Progress

VI. List of Collaborators and Long-term Associates

1. Dr. J.H. McAndrews, University of Toronto
2. Dr. D.B. Scott, Dalhousie University
3. Dr. P.J. Mudie, GSC-Atlantic
4. Mr. S.M. Blasco, GSC-Atlantic
5. Dr. K.J. Tinkler, Brock University
6. Dr. C.F.M. Lewis, GSC-Atlantic

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
OFFICE OF ATMOSPHERIC AND OCEANIC RESEARCH
Great Lakes Environmental Research Laboratory
2205 Commonwealth Boulevard
Ann Arbor, Michigan 48105-2945

September 11, 2003

Dr. John King
Graduate School of Oceanography
University of Rhode Island
South Ferry Road
Narragansett, Rhode Island 02882

Subject: NOAA leveraged funds in support of NSF proposal: *Understanding Sensitivity of Great Lakes Water Levels to Climatic Forcing: Closed Lake Status 8.4-6.8KA (9400-7700 CAL)*

Dear Dr. King:

The Great Lakes Environmental Research Laboratory, National Oceanic and Atmospheric Administration, will support the research described in the subject proposal. This includes 3 months of Dr. Croley's time over the next two calendar years ($55K) and contribution toward ship time during the first year ($7.5K).

Thank you for your attention.

Sincerely,

Dr. Stephen Brandt
Director, GLERL

Terrain Sciences Division

601 Booth St.
Ottawa, ON
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Sept. 3, 2003

Dr. J.W. King
Professor
Graduate School of Oceanography
University of Rhode Island
South Bay Campus
Narragansett RI 02882
USA

Dear Dr. King,

I am writing to support your proposal to the National Science Foundation to undertake paleoclimate research on the Great Lakes and on small lakes within the Great Lakes watershed.to determine the sensitivity of the Huron-Michigan sector of the Great Lakes hydrologic system to high-amplitude climate change. As you know, the Earth Sciences Sector (ESS), including the Geological Survey of Canada (GSC), of Natural Resources Canada, has approved a research activity under the title AGreat Lakes sensitivity of hydrologic response to paleoclimate change@ as part of its project in APaleo-environmental records of climate change@. This activity will be well-coordinated with the proposed NSF-supported research, and it will fund the research contributions of the scientists at Canadian institutions and ship time for obtaining samples. Total Canadian expenditures over the next three years for the Canadian Great Lakes research is approximately $150K US.

The major objectives of the research are to document the magnitude and timing of hydrologically closed lowstands that occurred during the early Holocene when the Great Lakes had entered their present non-glacial hydrologic status (8.4-6.8 ka) due to severe dry climate events, and to obtain a preliminary understanding of the sensitivity of the Huron-Michigan sector water levels to abrupt climate change by numerical modeling of the paleoclimate-hydrological system. Knowledge of past occurrences of high-amplitude, paleoclimate-driven lake-level changes will be critical to understanding the potential societal impacts of lake level changes resulting from global warming. Some scenarios of future climate change predict lowering of lake levels beyond the range of presently-known variability. The range and magnitude of activities in the NSF proposal will compliment and greatly enhance those planned for the ESS-GSC research and vice versa. The combination of the two research activities will produce a very credible binational program for contributing understanding about the vulnerability of the Great Lakes system to the impact of future climate change, a contribution that should be beneficial, for example, to the International Joint Commission in providing policy advice to Canada and the United States.

Sincerely,

Stephen Wolfe
Project Leader, Paleo-environmental Records of Climate Change Project
Geological Survey of Canada
601 Booth Street, Ottawa
ON K1A 0E8, CANADA