02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

Submit only ONE copy of this form **for each PI/PD and co-PI/PD** identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.B. Submission of this information is voluntary and is not a precondition of award. This information will not be disclosed to external peer reviewers. ***DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPROMISE THE CONFIDENTIALITY OF THE INFORMATION.***

PI/PD Name: Paul R Bierman

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 ☒

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
Race Definitions:
American Indian or Alaska Native. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.
Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

WHY THIS INFORMATION IS BEING REQUESTED:

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of its proposed PIs/PDs. To gather information needed for this important task, the proposer should submit a single copy of this form for each identified PI/PD with each proposal. Submission of the requested information is voluntary and will not affect the organization's eligibility for an award. However, information not submitted will seriously undermine the statistical validity, and therefore the usefulness, of information recieved from others. Any individual not wishing to submit some or all the information should check the box provided for this purpose. (The exceptions are the PI/PD name and the information about prior Federal support, the last question above.)

Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represented groups have the same knowledge of and access to programs and other research and educational oppurtunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

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PI/PD Name: Christine A Massey

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 ☐

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
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List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:

Henry Art, Environmental Science, Williams College, Henry.W.Art@williams.edu
Ronald Doel, Geology and History, Oregon State, doelr@geo.oregonstate.edu

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 04-23

NSF 04-613 **04/01/05**

FOR NSF USE ONLY

NSF PROPOSAL NUMBER

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

EAR - EDUCATION AND HUMAN RESOURCES

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				066811191	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)

030179440

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

0122005

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

University of Vermont & State Agricultural College

AWARDEE ORGANIZATION CODE (IF KNOWN)

0036962000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

University of Vermont & State Agricultural College
340 Waterman Building
Burlington, VT. 054050160

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

PERFORMING ORGANIZATION CODE (IF KNOWN)

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE

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 **Landscape Change Imagery: preparing a DLESE-ready and easily searchable resource**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **24,489**	**12** months	**06/01/05**	

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
Department of Geology

PI/PD FAX NUMBER
802-656-0045

PI/PD POSTAL ADDRESS
Delehanty Hall
Colchester Ave
Burlington, VT 05405
United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **Paul R Bierman**	**PhD**	**1993**	**802-656-4411**	**pbierman@uvm.edu**
CO-PI/PD **Christine A Massey**	**MS**	**1995**	**802-656-1344**	**cmassey@zoo.uvm.edu**
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

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 04-23. 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

The undersigned certifies, to the best of his or her knowledge and belief, that:

(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.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Sarah A Cooley**		**02/09/05**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
802-656-3360	**sarah.cooley@uvm.edu**	**802-656-1326**

*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

Landscape images are a powerful tool for doing and teaching Earth surface science because they provide a personal and human-scale linkage to geologic processes and the geography of place and time. However, in order for such imagery to be useful, it must be easily findable by those who wish to use it both in and out of the classroom. With this proposal, we request limited support targeted directly toward increasing the ability of scientists and educators to find landscape imagery for use in both formal and informal science education as well as scientific research.

The work proposed here builds directly on the education, research, and outreach success of the *Landscape Change Program* (uvm.edu/perkins/landscape), a 10,000+ image web-based archive that we have developed over the past 6 years with NSF support (Bierman et al., 2005). Here, we seek funds to prepare the existing image archive for inclusion in the *Digital Library for Earth System Education* (DLESE) as a collection as well as to create, test, and refine finding aids for the *Landscape Change Program* archive itself. This project builds on work we have done with imagery over the past six years that has catalyzed both formal and informal science education from K-12, to college, graduate school, and beyond.

Specifically, this proposal will support the standardization of metadata and image descriptions in the database so that the information can be harvested for inclusion as a collection in DLESE. Additional support is requested to improve the ability of users to find any one of the 10,000+ images within the *Landscape Change Program* archive by redesigning the current search page and by annotating images in such a way that *Goggle*-type web crawlers, and thus image and text searches, are more likely to find individual images. Throughout the process, Cathyrn Manduca and the staff of the Science Education Research Center (SERC, Carleton College) will assist in development of finding aids. The funds requested in the proposal would normally have been requested as a supplement to our existing grant, NSF GEO-0122005, but provision of an REU supplement for the summer of 2004 prevented further supplementation of the existing award.

Intellectual Merit – In the past decade, the world-wide-web has changed the way imagery can be used and accessed. Formal and informal science education can be done in wholly new ways. Place-based learning and understanding human-geology linkages over space and time are not only fundamental to Earth science education, they are critical to human survival as recent events (Indonesia's tsunami) so disastrously indicate. This proposal will add a resource containing over 10,000 fully described and key-worded landscape images to DLESE as well as make these images far more findable to the public and researchers using other portals for entry such as *Google* and the search engine within the *Landscape Change Program* web site.

Broader Impacts – There is no better way to catch people's attention and promote an informed citizenry, than the scientific, environmental, and historical awareness catalyzed by the visceral impact of imagery. Work funded by this proposal will positively impact those using both DLESE and the *Landscape Change Program* web site. The work we propose will provide an example on a national level of how to annotate and search for images in such a way that they are easily findable by those who need to use them for education and research. This project includes roles for undergraduate and graduate students as well as a K-12 educators and K-12 students.

TABLE OF CONTENTS

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

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

RESULTS OF PREVIOUS SUPPORT

Bierman has received 18 grants or subcontracts from the NSF since coming to the University of Vermont in 1993. Three of the grants Bierman has received from NSF are directly relevant to the project described in this proposal; thus, their results are summarized below. Two of these grants were with CoI Massey, University of Vermont, Education Department.

EAR-9702643, $200,563, 8/1/97-7/31/02, NSF Hydrologic Sciences, CAREER award -- Timing and Distribution of Extreme Hydrologic Events.

This award integrated research, research training, and education for undergraduate- and Masters-level students. The research identified periods of extreme storminess in New England during the last 14,000 years using radiocarbon dating, soil trenching, and lake coring to understand the distribution of thick, storm-induced layers of sediment in lakes and on alluvial fans. Over 5 years, the grant supported the research of 5 undergraduates and 6 MS candidates, as well as 14 abstracts at national meetings and 10 publications including six first-authored by students: one in *NATURE* (Noren et al., 2002), one in *GEOLOGY* (Brown et al., 2000), one in *GSA Bulletin* (Jennings et al., 2003), one in the *Journal of Paleolimnology* (Brown et al., 2002), and two in the *Journal of Geoscience Education* (Gran et al., 1999; Nichols et al., 2003). Four other publications were led by faculty (Bierman et al., 1997; Bierman and Robison, 2000; Bierman et al., 1999; Wright et al., 1997). During the grant, students in Bierman's undergraduate major-sequence classes (Geomorphology, Hydrology) were deeply involved in the research -- logging trenches, coring ponds, and analyzing cores.

EAR-0122005, $99,649 (with $13,970 REU supplement), 9/1/01-2/27/05, Geoscience Education, Looking Forward -- Scaling Up the Digital Image Archive of Landscape Change and *EAR-9907724, $74,717, 9/1/99-8/30/01 Human-Induced Landscape Change -- A Digital Image Archive Created by Students*. CoI, C. Massey.

The *Landscape Change Program* began in 1999 with pilot funding from NSF to Bierman and Massey. Initial funding supported the development of a web site and curricular materials designed to bring the study of landscapes and the changes they reflect to high school classrooms via a traveling instructor as well as the informal science community via the world-wide-web. The program was a success. After two years, curricula had been developed, there were more than 800 images online, and hundreds of students had investigated landscape changes in their communities through the dozen high school teachers with whom we worked. By 2001, advances in web technology and the increasing number of images we were collecting and being offered, led to a second round of funding from NSF. This support was specifically targeted to expanding the collection, moving the image archive to an open-source data base structure, and diversifying the populations served by the archive. Over the past three years, we have developed all-new software to manage and display the archive. We now house more than 10,000 images and see 40,000 to 60,000 individual hits per week on the website from > 2500 unique IP addresses. Five undergraduate students, a K-12 teacher, several high school students, and the faculty and staff associated with the project have presented 8 papers at professional meetings (Bierman et al., 2004a; Bierman et al., 2004b; Bierman, 1999; Mallard et al., 2000; Massey et al., 2003; Massey et al., 2000; Persico et al., 2000; Stanley Mann et al., 2004) as well as publishing a book chapter (Bierman and Robison, 2000). An REU supplement (summer 2004) involved three undergraduates who presented results at GSA Denver (Bierman et al., 2004a; Stanley Mann et al., 2004) and as the cover story (Bierman et al., 2005) for the April 2005 issue of *GSA Today*. We actively collaborate with numerous town historical societies and state repositories and archives.

PROJECT DESCRIPTION

The *Landscape Change Program* an interdisciplinary way to teach and do science

The *Landscape Change Program*, an NSF-funded initiative we have created at the University of Vermont, is an example of how to do and teach science using images. At the program's core is a web-based, community archive of Vermont landscape imagery currently containing over 10,000 images acquired from individuals and more than a dozen public archives (Figure 1). It is available free of charge, on-line, to both the general public and to researchers in any field of study at http://www.uvm.edu/perkins/landscape/ (Figures 2 and 3). The project was conceived to provide researchers and students in the natural sciences, especially geologists, geographers, and ecologists, with a resource to study how human activities and natural events have shaped the landscape since European settlement of New England (Massey et al., 2003). The archive began as a K-12 educational tool with the goal to cross boundaries between the sciences and the humanities by using landscapes (Massey et al., 2000); it has maintained that focus while growing to incorporate undergraduate involvement (Bierman et al., 2004a). The mission statement for the *Landscape Change Program* articulates its interdisciplinary focus:

> *The mission of the Landscape Change Program is to preserve, present, organize, and make widely accessible, images of Vermont landscapes as they were and as they are. Our goal is to illustrate the complex interaction and feedbacks between people and the physical, biological, and historical landscapes on which they live. Using images, we seek to integrate science, history, and the human experience.*

Over the past two years, interest in and use of the *Landscape Change Program* has grown explosively in part reflecting the success of a REU supplement (summer 2004) that brought three undergraduate students into the program. Their work formed the basis of poster presentations at national GSA (Bierman et al., 2004a; Stanley Mann et al., 2004) and a cover story for the April 2005 issue of *GSA Today* (Bierman et al., 2005). The continued growth of the archive has been exciting, has allowed students associated with it to do relevant science and be trained in research methods (Bierman et al., 2005), and has greatly increased public awareness of and use of the archive (Figure 4). The growth in the *Digital Library for Earth System Education* (DLESE) and the *National Science Digital Library* (NSDL), and interest from the former organization in accessioning collections with utility for science education, has occurred concurrent with the growth of the *Landscape Change Program* archive.

Statement of problem

If images from the *Landscape Change Program* archive were directly accessible in DLESE and from the NSDL, many more educators and researchers could have easy access to them. Similarly, the heavy use of search engines such as *Google* to find information and images, suggests an important means by which to disseminate imagery in the *Landscape Change Program* archive. Ready access to specific images also requires easy, fast, and reliable searching from within the archive.

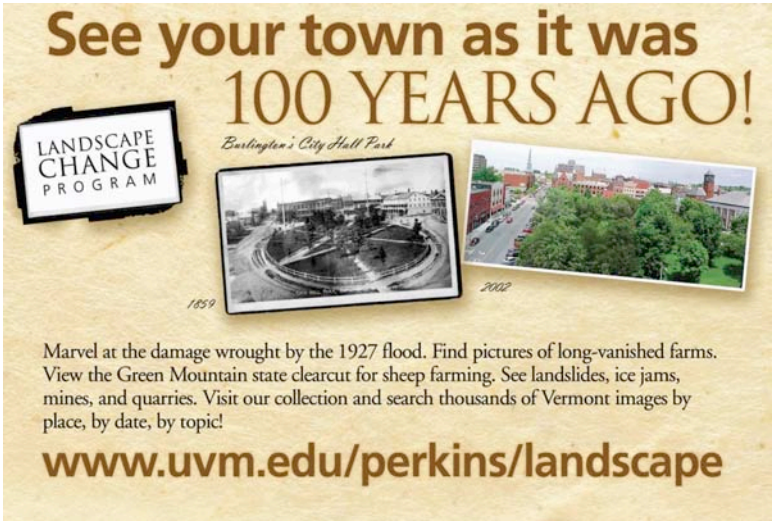

Figure 1. Information postcard and part of poster for *Landscape Change Program*. Poster distributed to all libraries, town offices, historical societies, state offices, and legislators in Vermont during February 2005. The posters feature tear-offs including the web site URL.

Figure 2. *Landscape Change Program* home and splash page with top bar navigation to all main sub pages and bottom bar attribution to sources of project support. This revised page and navigation structure developed in response to external project evaluation by Carleton's SERC, April 2004.

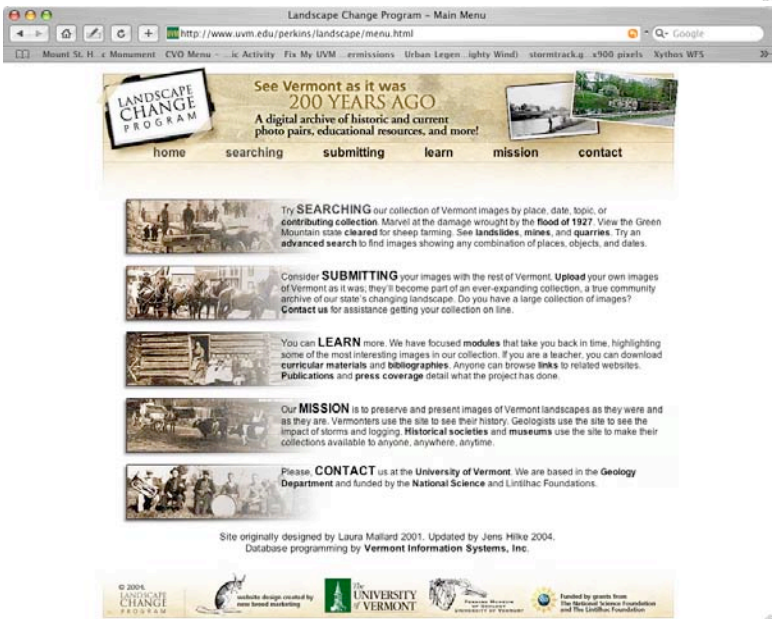

Figure 3. *Landscape Change Program*, main navigation and explanation page enabling visitors to reach main site content quickly. This revised page and navigation structure developed in response to external project evaluation by Carleton's SERC, April 2004

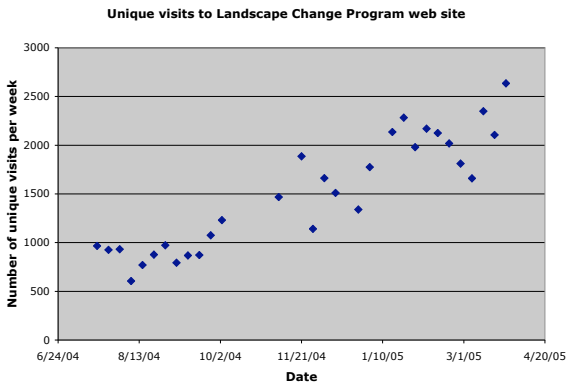

Figure 4. Starting in July 2004, we have been automatically logging web traffic to the *Landscape Change Program* site. Number of unique visits per week to *Landscape Change Program* web site, as determined by logging IP addresses of visitors, has steadily risen. Each visitor usually views 5 to 10 pages when they visit the site. On average, each visitor returns to the site twice a week generating a total of about 50,000 hits per week

Our ability to interface the *Landscape Change Program* archive with DLESE, the NSDL, and *Google*-type search engines are currently limited. The largest obstacle is the existence of significant disparities regarding image description and key wording within the image archive database. This discrepancy is the result of *Landscape Change Program* archive growing in three distinct stages. Specifically, the first 800 images were collected by a combination of high school and university students and have varying types and depth of image descriptions. The next 2400 images were uploaded by project staff in a bulk fashion when the new web-based (php and MySQL database-driven) software was developed. Many of these images have little or no description. Most of the 3200 "early" images had only informal keywords, those based not on a controlled vocabulary but on a list of 42 terms supplemented by *ad hoc* keywords suggested by the person describing the image. The discrepancies in image description and key wording need to be addressed before we can apply to DLESE (and thus NSDL) for inclusion as a collection. Using remaining funds from our last grant, we have added Library of Congress keywords and detailed descriptions to the first 500 images. About 2700 images remain inconsistently keyworded and inadequately described, thus limiting users' ability to find them reliably.

In the spring of 2004, prior to the involvement of the REU students, we refined our image description protocol working with UVM library staff. We developed a key-wording protocol based on the Library of Congress (LOC) *Table of Authorities*. Of the later 7200 images in the archive, over 98% are key-worded with this controlled vocabulary.
See: http://www.uvm.edu/perkins/landscape/keyword_selector.htm
At the same time, we developed and continued to refine an image description protocol that resulted in standardized, detailed, and far more reliably searchable image descriptions. Thus, almost all of the most recent 7200 images accessioned to the archive have detailed image descriptions and LOC controlled vocabulary keywords associated with them.

The rapid growth of the archive to over 10,000 images has taxed the simple search engine developed with our software. With so many images from single towns (over 550 for Burlington) or with similar keywords (over 400 for erosion and 3000 for road), it has become increasingly difficult to find particular images because the existing search engine

does not allow structured searches (with Boolean modifiers "and/or") or searches within results of prior searches. Furthermore, a *Google* image search returns only a few images from the *Landscape Change Program* archive, those used in hard-coded html pages rather than those in the php/MySQL-driven archive.

The problem we face is three fold. First, before inclusion in DLESE and NSDL, we need to standardize all image descriptions and key-wording. Second, to simplify image finding, we need to modify the existing search engine so that all images (including those to be key-worded and described as part of this proposal) can be efficiently located from within the archive. Third, to continue expanding the reach and utility of the archive, we need to modify the web presentation to increase the likelihood that all images can be found with a *Google*-type search of the web.

Project goals

The overall goal of the project described in this proposal is straightforward. We seek to improve the ability of scientists, educators and the public to find relevant images in the *Landscape Change Program* archive. Finding such images is prerequisite to using them in teaching, research, and informal science education. We will approach this overall goal by meeting three discreet goals.

1. We will edit the image descriptions as well as include Library of Congress key-wording for about 2700 images in the *Landscape Change Program* archive that are not well described and are not fully keyworded. We will spell check all remaining image descriptions and ensure the completeness and LOC key-wording and textual description of all 10,000+ images in the database. When this is done, the entire 10,000+ image archive will be proposed to DELSE (and thus incorporated in NSDL) as a collection.
2. As image descriptions and key-wording are standardized, we will work with University of Vermont staff and those at SERC to redesign and modify our current search engine so it is easier to find images within the archive.
3. We will work with staff at SERC and the University of Vermont to identify and include means by which all 10,000+ images in the *Landscape Change Program* archive are searchable by common web search engines such as *Google*.

Key to meeting the second of the three goals outlined above is the direct and continued involvement of a K-12 educator and both University and High School students in the process of refining resources (the search function) to be shared nationwide (via the world wide web) in the both formal and informal science communities.

Human-landscape interaction and the importance of imagery as a catalyst for learning

For millennia, people have altered landscapes and landscape-scale forces have affected people. Such alteration began with land clearance for agriculture at least 9000 years ago and was soon followed by the construction of roads, buildings, and cities (Hooke, 2000). Today,

people are the most active geomorphic force on the planet, moving more mass every year than all other natural processes combined (Cronon, 1996; Hooke, 1994).

The landscape response to human activity is unambiguous; workers have documented human-induced desertification (Zheng and Eltahir, 1997), the impacts of road building (Wemple et al., 2000), and the relationship between clear-cutting and landslides (Montgomery et al., 2000). More than a hundred years after Marsh wrote *Man and Nature,* lamenting the clearing of hillslopes and the erosion that followed, David Brower and the environmental movement used imagery of a flooded Grand Canyon (Nash, 1967) to bring these modern-day human impacts clearly and viscerally into the public eye (Figure 5). Ever since, debates fueled by dramatic, emotion-inducing photographs, have raged over logging, road building on wild lands, and the alteration and restoration of rivers in the context of protecting endangered species (Montgomery, 2004).

Images show how natural forces alter human lives and societies, be it landslides destroying California homes or the devastating power of tsunamis washing over entire nations. With the internet, images are transmitted immediately to people around the world. Not only has informal science education become image and data-rich but formal science training now depends heavily on imagery and computer-aided visualization (Marlino et al., 2004). The trend is not surprising; images can code, display and preserve information far more densely that words (Strausz, 2001).

Now Only You Can Save Grand Canyon From Being Flooded…For Profit

Figure 5. Images matter! Here is the photograph (right) that lost David Brower and the Sierra Club their tax-exempt status for "lobbying" to save the Grand Canyon from flooding. Image (altered by BLM in 1949) shows proposed location of Bridge Canyon dam and associated reservoir. The headline above topped the full-page *New York Times* advertisement in which the image appeared on 6/9/1966.

The role of images in teaching and doing interdisciplinary science

Geoscientists are key providers of both data and student training for environmental management and disaster prevention because we understand relevant earth processes (Schneiderman, 2000). Much of what we know and teach about Earth is rooted in the mapping of Earth materials (for example, volcanic mudflow deposits). Such mapping, often coupled with dating, lets us infer both the spatial and temporal distribution of geologic processes over millions of years. But what's to be done on shorter time scales, those most relevant to people and societies? Experimental studies gather data over grant funding cycles and occasionally over decadal time scales (e.g., Hawaiian CO_2 record), but the time scale over which human impact is most pronounced, the last century, is difficult to approach in a traditional geologic fashion.

The *Landscape Change Program* exemplifies a different approach. We argue that historical landscape images can be used to both understand and teach about the distribution of processes active at and near Earth's surface over the last 100 to 150 years and that both individually and as a group such images are a powerful tool to do and teach science both formally and informally. By examining both cultural and natural features, one can infer how societal changes have shaped landscapes as well as inferring how landscape-scale processes have shaped societies (Bierman et al., 2005). This approach is a bridge between short-term instrumental records and geologic techniques that are often more useful over longer timeframes. Using images is also a means to bridge disciplinary boundaries and interest people who otherwise view science as irrelevant or dull (Butler et al., 2003).

Images as a way to teach science

Over the past decade, numerous studies have repeatedly identified Earth Science as important and relevant to students at a variety of levels (Kelley and Burks, 2003; Shaver and Wood, 2004; NESTA, 1987; AGU, 1996; Yuretich et al., 2001). As a result of this attention, there have been calls for innovative curricular development emphasizing student involvement in the learning process and the use of the research process as a catalyst for learning (St. John and Callahan, 2003; AGU, 1996, Yuretich et al., 2001). However, anecdotal reports and statistically-based findings suggest that students consider much of Earth Science irrelevant and disconnected from their lives (Kanfoush, 2003; Chaudhri and Kaur, 2003; Miller, 2002; Yuretich et al., 2001).

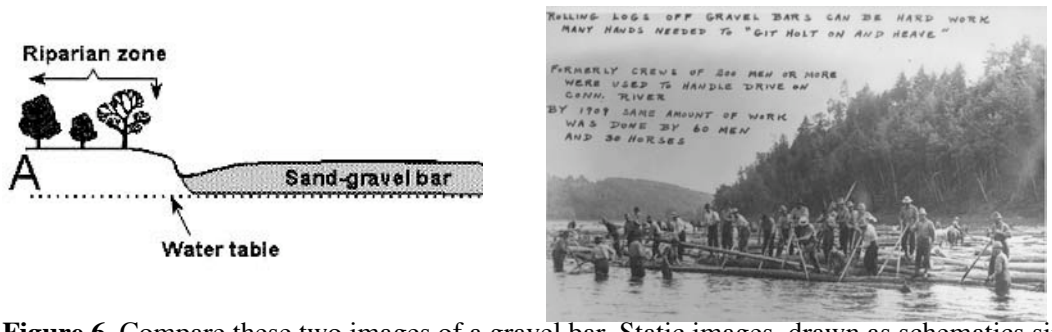

Figure 6. Compare these two images of a gravel bar. Static images, drawn as schematics similar to that on the LEFT can be found on many websites and in many textbooks; image from http://threeissues.sdsu.edu/three_issues_sandminingfacts02.html. Such images represent what is seen photographically in the RIGHT image from the *Landscape Change Program* archive (http://www.uvm.edu/perkins/landscape/LS_FullDisplayM.php?FN=LS02113_000.jpg). Here, there are people and there is action. The caption sets the stage for a story telling us that men are moving logs off a gravel bar. The photograph is a catalyst for engaging discussions about the geomorphic effects of logging and riparian buffers. Teaching with both images gives the gravel bar meaning in a human context.

Such a disconnect between student perception and reality is not surprising when one considers both the spatial and temporal scales at which most Earth Science is taught and the level of abstraction typical of diagrams used to illustrate germane topics (Figure 6). Open any textbook and examine the rivers chapter. There you will find diagrams classifying stream morphology. There is little consideration of scale, no reference to time, and diagrams

are typically devoid of people or represent them and their constructs schematically. What a contrast to images we see daily in the media -- homes inundated by floods, buildings collapsing as banks erode, and livestock stranded by rising water. These images present tangible links between Earth Science and the human condition. Earth scientists, trained in the linkages between process, outcome, and time have much to offer in terms of understanding complex environmental and societal issues.

Based on evidence from half a decade of working with students and images, we have been funded ($75,000; 4/05 – 3/07) by NSF's EMD program to pilot development of web-based learning modules based on historic imagery. At the core of this project is the idea that learners respond better to images than text and that local images provide a sense of place and context. Improvements in image finding supported by this proposal are synergistic with the EMD work and will catalyze better, more in depth and effective learning experiences. Specifically, students will be able to find more easily and reliably the images they need to learn.

Work Plan

The work plan has three parts: TASK 1) image description and key-wording; TASK 2) refining existing search function, and TASK 3) incorporating code so that web-based search engines, such as *Google*, can find and search every image in the archive.

TASK 1. Image description and key wording

We have worked with Ms. Katy Ginger, of the DLESE Program Center, to review metadata requirements and other tasks necessary prior to submission of the *Landscape Change Program* archive to DLESE. Inclusion of images in DLESE as a resource collection requires that every image be key-worded and described according to set policies described on the DLESE web site: http://www.dlese.org/Metadata/collections/collection-how-to.htm. Furthermore, all entries need to be spell checked prior to submission. In order for the *Landscape Change Program* archive to meet this standard, about 2700 images need to key-worded and described in detail and all 10,000+ image descriptions need to be checked for completeness and spell checked.

To determine the level of effort required to complete this task, we used the last funds remaining on our existing NSF budget to continue supporting Ms. Megan McGee who has worked part time for the project since 2003. Megan, who graduated from UVM in 2003 with an Environmental Science degree concentrating in Geology, has described and key worded over 1500 of the images uploaded for the project. She is experienced, thorough, and efficient.

Doing the first 500 images in the archive, we determined that it took on average about 12 to 15 minutes per image to do keywords and detailed descriptions. This works out to processing speed of 4 to 5 images per hour, suggesting that doing the remaining 2700 or so images will take about 650 hours. Checking the remainder of the archive database for spelling and completeness should take another 100 hours.

Describing and key-wording each image requires viewing the high-resolution files and identifying the major landscape elements in the foreground, middle ground, and distance. We describe in detail the morphology and channels of streams and rivers, note landslides, and carefully characterize vegetation distribution and type as well as season. Riparian zones and outcrops are described. We transcribe signs and note all human impacts on the landscape. On the next page is an ***Example Image Description***, which demonstrates the process we follow in making detailed, searchable descriptions. The trick here is that we are trying to put in words what the eye sees, so that images and their content can be searched. For efficiency, key wording is done with image description. When TASK 1 is completed, we will submit the *Landscape Change Program* archive as a resource collection to DLESE.

TASK 2. Refining existing image search function

The current search options (http://www.uvm.edu/perkins/landscape/search_collection.php) available to users of the *Landscape Change Program* archive are limited to graphical searching by town and country (a popular approach), searching by date, searching by a short list of key words, and free searching for text in any data base field. It is not yet possible to search within results, nor is it possible to search for multiple text terms or to search for text restricted to a range of dates.

In consultation with Carleton's SERC, we plan to completely redesign both the basic and advanced search pages. First, we will examine search strategies used by other image archives including those listed in the data repository of Bierman et al. (2005). This survey will provide a range of options for us to consider implementing.

Second, we will work with SERC to design an evaluation survey to understand better what type of search strategies would be most useful to different users of the archive. We will administer the survey in person to a variety of different people including, students at different levels (high school to graduate school), faculty, community members, and university staff. Some surveys will be administered at remote locations (high schools); others will be done in a group setting at the University of Vermont. Manduca will be present for the first group evaluation in order to train us in the acquisition of data by working with people at terminals. To reduce cost, will perform this initial evaluation during one of Manduca's trips to Vermont funded by the EMD grant.

Based on the results of the initial surveys and interactions with SERC personnel, we will work with programming staff at the University of Vermont to do initial revisions of both the basic and advanced search pages. Once an initial redesign of the search pages is complete, we will again test them with a user survey designed in concert with experts at SERC. In response to user comments and suggestion, we will make further modifications and finalize the new search pages.

When TASK 2 is completed, there will be a flexible, user-friendly search engine enabling users to find images by either by date, key words, image description, source archive, location, time of acquisition, or a combination of these attributes. This search structure could be adopted by other image archives and should be readily transferable technology.

EXAMPLE IMAGE DESCRIPTION AND KEY-WORDING

The most visual element in this image are the ox teams and carts so we start the interpretation this way.

This image shows a horse team and two ox teams. The horse team is hitched to a four wheel cart. One ox team is hitched to a two wheel cart and the other is unhitched. The carts appear empty. The teams are on a poorly defined dirt road. In the foreground is grass cut short with a few rounded stones interspersed.

We continue with related information.

A man is sitting in one of the carts and another man is standing next to the unhitched team carrying a short stick or whip. There is a woman in the background with a girl near a bridge over a stream. The riparian zone of the stream is barren; there is no riparian vegetation to form a buffer zone.

Mentioning the bridge, leads to the stream.

The wooden bridge crosses a stream that is dammed near the left side of the image. The dam is made of logs and to the left of the dam is a connected building. It is likely a sawmill because cut lumber is stacked all around the building and there is another pile of lumber just over the bridge by the road. Behind the dam, sediment is accumulating, filling the mill pond.

Now, cross the road and move up the hill into the background.

The road heads up a gentle hill to a farmhouse near the right side of the image. Lumber is stacked along the fence that borders the road. Behind the house are a barn and several outbuildings. They sit in open, cleared fields with what appear to be some fruit trees (apple?) just behind the house. There are some lone trees in the upper fields. The fields stretch up an increasingly steep hill to the ridgetop which is forested. There are walls or fences dividing the fields. No erosion or landslides are visible.

Try and ferret out the season using whatever clues are available.

It is either fall or spring as the trees have no leaves but the stream is flowing and there is no snow.

Key Words: Open_fields; Agriculture; Animals; Barns; Bridge approaches; Bridges; Bridges, Wooden; Buildings; Cattle; Conifers; Dams; Deciduous; Dwellings; Earth Materials; Factories; Farm buildings; Farming; Forests and Plants; Geology; Girls; Hills; Horses; Human Activity; Human Constructs; Industrial buildings; Landforms; Landscapes; Living Things; Logging; Lumber; Men; Nature; Oxen; Pasture plants; Pastures; Pebbles; People; Plants; Ponds; Riparian plants; Rivers; Roads; Roads ,Earth; Rural; Rural roads; Sawmills; Sediments (Geology); Shrubs; Stone walls; Stone walls and Fences; Traditional farming; Travel with horses; Trees; Women; Wooden fences; Wooden-frame buildings; Work.

TASK 3. Making the *Landscape* archive searchable using web-based search engines

Google, and other web-crawler based search engines, index pages that can be found through simple mouse clicks on simple links. However, the web pages that display the 10,000+ images of the *Landscape Change Program* cannot be accessed by links because the pages are dynamically generated in response to user-generated searches; thus, image-display pages, and the metadata and descriptions they contain, do not exist until they are requested. As a result, our 10,000+ images and their descriptions are not reliably indexed by *Google* and other search engines. Because our goal is to reach as many people as possible with the images and content in the collection, we need to find a way to improve the collection's chances of being indexed by web crawlers such as *Google*.

The solution is straightforward. Our plan is to add a "Browse" mechanism in addition to a "Search" mechanism. Indeed, we have such a mechanism for finding images except it is available only through a graphic interface, clicking on the map to burrow down to the town level where all images are accessible (Figure 7). This is a finding method loved by users and ignored by *Google*. By adding a text alternative (a list of counties) to the graphic interface, we will allow web crawlers to directly access all images, their associated keywords, and textual descriptions. The addition of a textual alternative to the graphic interface will also improve site accessibility for the visually impaired, another benefit.

Figure 7. Screen capture of basic search page showing graphical, location-based search map as well as text search for keywords, dates, and towns.

When TASK 3 is completed, a web search using *Google* or another similar search engine should be much more likely to identify relevant images in the *Landscape Change Program* archive. The result will be a far more widely accessible and findable archive of imagery.

Evaluating Project Success

Evaluating the success of this limited-scope, short-term project is relatively straightforward. Task 1 will be completed and considered successful when all images in the archive have been keyworded using Library of Congress, *Table of Authorities* terms, all images have been described in detail sufficient to allow reliable searching, and the *Landscape Change Program* archive submitted to DLESE as a collection. The success of Task 2 will be determined by comparing the evaluation instruments administered to representative users in small sessions before, during, and after the iterative process of altering the search function. The effective completion of Task 3 will be monitored by checking *Google* and other search engines such as *Yahoo* on a monthly basis to determine if images from the *Landscape Change Program* archive are found in searches.

Intellectual Merit

This *Landscape Change Program* is grounded in the successes we and others have had engaging students through place-based and visually-centered learning. Our overall project goals are significant, exploring unusual ways to link research and education via imagery and distributing widely a philosophy that has worked so well for us, the idea that images of local landscapes are valuable for education and place-based learning. The project detailed in this proposal will continue our close linkages with Cathy Manduca and Carleton's *SERC*, the premier center for evaluating and revitalizing science education. PI Bierman and others involved in this effort have significant experience in all aspects of the project. Over the past 6 years, they have established and improved the *Landscape Change Program,* a unique searchable archive of landscape imagery (Bierman et al., 2005). Bierman and his students have worked together to develop and disseminate educational materials and approaches for several different classes that use best practices for conveying information at a variety of levels (Butler et al., 2003; Clapp et al., 1996; Gran et al., 1999; Nichols et al., 2003). Massey has worked with K-12 educators and students for over a decade, organizing a variety of pre-service and in-service programs; she directed the creation and implementation of the *Perkins Museum Digital Archive*, an IMLS-supported collection of 12,000+ images of rocks and minerals (uvm.edu/perkins). Together, we bring to this project energy, enthusiasm, and the desire to fundamentally change how science is taught at many levels.

Broader Impacts

This work has significant broader impacts. By including >10,000 images already in the *Landscape Change Program* archive in DLESE and the NSDL, we will significantly enrich these resources. Placing images in these collections will in turn greatly increase the number of people using the images and associated resources we have developed. The *Landscape Change Program* brings the scholarly work of Universities directly to both the local and national informal and formal science community; this is science education one image at a time as pictures and their captions spill over the internet to communities and educators everywhere. Work supported by this proposal will continue to involve students at both the high school and university level; in this case, they, along with a high school teacher, will be involved in the testing and refinement of the new search engine.

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(i) Professional Preparation

Ph.D., 1993, Geology, University of Washington, Seattle, WA with A. Gillespie
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MS, 1990, Geology, University of Washington, Seattle, WA with A. Gillespie
"Accuracy and Precision of Rock Varnish Cation Ratio Dating"
BA, 1985, Geology and Environmental Studies, Williams College, Williamstown, MA
"Deglaciation of Northwestern Massachusetts" (cum laude and senior thesis)

(ii) Appointments

2002-present	Professor	Univ. Vermont, Geology and Natural Resources
1998-2002	Associate Professor	Univ. Vermont, Geology and Natural Resources
1993-1998	Assistant Professor	Univ. of Vermont
1992-1993	Lecturer	University of Washington
1993	Visiting Researcher	University of Adelaide
1987-1992	Research and Teaching Assistant	University of Washington
1985-1987	Hydrogeologist and Project Manager	Alliance Tech., Bedford, MA
1985-1987	Instructor	Museum of Science, Boston

(iii) Publications

(i) 5 publications most closely related to the proposed project

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(ii) 5 most significant publications,

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Bierman, P. and Steig, E. (1996) Estimating rates of denudation and sediment transport using cosmogenic isotope abundances in sediment. **Earth Surface Processes and Landforms,** 21, 125-139.

(iv) Synergistic Activities

Innovations in teaching and training – Development of student-centered, inquiry-based, data collection courses in Geomorphology and Geohydrology documented in 3 refereed papers in the Journal of Geologic Education (2003, 1999, 1996). Creation of introductory Earth Hazards class for non-science majors with integrated discussion sections to increase student interest and involvement, documented in refereed lead article in EOS (2003).

Development of data bases to support research and education -- Creation of web-based Landscape Change archive with thousands of images of human/landscape interaction dating back to 1850. Used for research and K-16 education. http://www.uvm.edu/perkins/landscape/

Service learning and service to community -- Urban hydrology projects with classes and interns working with Burlington city government to document loss of greenspace and increase in run off from campus neighborhoods. Documented in Nichols et al. (2003, Journal of Geologic Education). Associate Editor, Geology and GSAB; editorial board, DLESE.

Development and refinement of research tools – Fundamental work with graduate students developing and refining use of cosmogenic nuclides for monitoring rates of surface processes. Five major review publications (1994, 1998, 2001, 2003, 2004) and 26 refereed articles and book chapters with new cosmogenic data. Developed tools for reconstructing Holocene paleostorminess history of New England under NSF CAREER support. Donath Medal for Research by Young Scientist, Geological Society of America, 1996.

(v) Collaborators & Other Affiliations

(a) Collaborators and Co-Editors (48 months)

D. Dethier, Williams College; D. Clark, WWU; P. Davis, Bentley College; M. Caffee, Purdue; E. Steig, UW; J. Southon, UCI; Y. Enzel, Hebrew U.; A. Matmon, USGS; M. Pavich, USGS; P. Colgan, Northeastern; D. Mickelson, UW; C. Duncan, U Mass; K. Nichols, Skidmore; A. Gellis, USGS; E. Clapp, Sevee & Mahar; A. Elwein, USGS; P. Schroeder, U Georgia; N. Melear, U Georgia; M. Kashgarian, LLNL; K. Marsella, Skidmore; J. Larsen, UVM; R. Finkel, LLNL; L.Persico, UNM; T. Schildgen, MIT; K. Klepeis, UVM; M. McGee, UVM; S. Wright, UVM; S. Southworth, USGS; N. Porat, IGS; Amit, R., IGS; O. Crouvi, IGS; J. Briner, CU; G. Miller, CU, K. Jennings, USFS, S. Brown, OSU; A. Lini, UVM; A. Noren, U Minn; S. Gran, UW; D. Rizzo, UVM; P. Zehfuss, UW; J. Lekach, IGS.

(b) Graduate and Postdoctoral Advisors.

Alan Gillespie, University of Washington, graduate advisor
Rowl Twidale, University of Adelaide, postdoctoral sponsor

(c) Thesis Advisor and Postgraduate-Scholar Sponsor.

A. Matmon, Postdoctoral advisor, USGS; K. Nichols, Doctoral advisor, Skidmore College; E. Clapp, Doctoral advisor, Sevee and Mahar; L. Reusser, Doctoral advisor, University of Vermont; primary advisor, 4 PhD. and 16 MS students

Christine Ann Massey, Outreach Coordinator

Department of Education, University of Vermont, Burlington, VT 05405-0122

(i) **Professional Preparation**

Carleton College	Geology (with Natural History and German)	B.A.	1986
University of Washington	Geology	M.S.	1995

(ii) **Appointments**

1998-present	Museum Education Specialist Perkins Museum, Univ. of Vermont (UVM)
1995-present	Director Science & Technology Governor's Institute for VT H.S. Students
1996-1998	K-12 Outreach Coordinator Perkins Museum, University of Vermont
1993-1995	Environmental Consulting Geologist WH&N, Burlington, VT
1989-1993	Research and Teaching Assistant (Geology/Chemistry/Environmental Sciences/Northwest Center for Research on Women) Univ. of WA
1988-1989	Hydrologic Field Assistant U. S. Geological Survey, Menlo Park, CA
1986-1987	Naturalist Intern Foothill Horizons Outdoor Educ. Center, Sonora, CA

(iii) **Publications** *(5 related to this project)*

Bierman, P.R., Howe, J., Stanley-Mann, E., Peabody, M., Hilke, J., and Massey, C.A., (2005). Old landscape images record landscape change through time **GSA Today**. V. 15, n. 4, 10:1130/1052-5173(2005)015, p.1 –6

Massey, C. A., Hilke, J., and Bierman, P. R., (2003). Landscape Metamorphism in Vermont: Building an Image Archive of the Past and Present with Students, Historical Societies, and Towns. **Geological Society of America—2003 National Mtg. Abstracts with Programs**, 35 (6), p 121,

Massey, C. A., Elvin, D. W., and Mora-Klepeis, G., (2002). Digitizing the Collections of the Perkins Geology Museum to Support On-line Learning Applications about Vermont Geology, **Geological Society of America—2002 National Mtg. Abstracts with Programs**, 34 (6), p. 455.

Massey, C. A. (2001). Digital databases at the Perkins Geology Museum, **Geological Society of America—2001 National Mtg. Abstracts with Programs**, 33 (7), A-122.

Massey, C. A., Mallard, L. D., Bierman, P. R., (2000). Digital archive of human-induced landscape change with K-16 students in Vermont, **Geological Society of America—2000 National Mtg. Abstracts with Programs**, 32 (7), A-204.

Publications *(5 other)*

Massey, C. and Snyder, S., (1999). Geologic field trips sites for teachers in Northwestern Vermont. In Wright, S. F. ed., **New England Intercollegiate Geologic Conference Guidebook**, 91, 159-177.

Massey, C. A., (1998). Earth Science Week. **Connect: Teacher's Innovations in K-8 Science, Math and Technology**, 12, 1, 26.

Massey, C. A., (1998). Learning through inquiry and community service--The Science & Technology Institute for Vermont high school students. **Geological Society of America--1998 National Mtg. Abstracts with Programs**, 30, 7, A-350.

Massey, C. A., (1997). Environmental Science and Technology Institute for Elementary Teachers and Education Majors in Vermont. **Geological Society of America--1997 National Mtg. Abstracts with Programs**, 29, 6, A-301.

Massey, C. A., (1996). Thrust faults, plankton tows, wastewater, and SEMs: Vermont Earth and Environmental Science for K-12 students and teachers. **Geological Society of America--1996 National Mtg. Abstracts with Programs**, 28, 7, A-476.

(iv) **Synergistic Activities**

Perkins Digital Image Archives

-Coordinate and direct activities for the Institute for Museum and Library Services (IMLS)-funded project to digitize the collections of the Perkins Museum and for the NSF-funded Landscape Change Program (http://www.uvm.edu/perkins).

-Participate in digital library conferences/meetings: Digital Library for Earth System Education (DLESE), WebWise (IMLS-sponsored), NE Document Conservation Center (NEDCC), National Science Digital Library (NSDL), and UVM Digitization Center.

Formal Science Education

-Teach *Intro. Geology, Fire and Ice,* and *Geology of Nat. Parks* courses through the Continuing Education Division at the University of Vermont; *Regional Geology* to Geology Majors; and *Science in Vermont* to Elementary Teachers and Educ. Majors.

Informal Science Education

-Direct summer science programs at the UVM Perkins Geology Museum including: *Governor's Institute on Science and Technology* for capable high school students, *Summer Science Adventure for Girls* and *for Boys* in middle school, and *Environmental Science Day Camp* for elementary students.

-Facilitated outreach for Perkins Museum visits, tours, teacher geology resource needs, and teacher professional development.

-Coordinate the *JASON Project* in Vermont (interdisciplinary, multi-media, supplementary science curriculum for grades 4-9).

Service and Equity Training

-Three-year appointment on the UVM *President's Commission on the Status of Women.*

-Short course participant in *Engaging Middle School Girls in Math & Science*, *Diversity at UVM*, *Equity Workshop for K-12 Educators*, *Accessibility to Websites,* and *Lead-Scientist Institute on Systemic Reform of Elementary Science Education.*

-*Science-By-Mail* volunteer scientist mentoring elementary students (1992-2000).

Professional Memberships

-GSA, AGU, NAGT, AWG, Vermont Geological Society (Vice President-1999; Education Chair-2000 to present), and Vermont Science Teacher's Association.

(v) **Collaborators and Other Affiliations**

(a) *Collaborators (last 48 months):* Russell Agne (UVM Education), Paul Bierman (UVM Geology and Natural Resources), Barry Doolan (UVM Geology), David Elvin (VT Info. Systems, Inc.), Jens Hilke (UVM Geology), Laura Mallard (Appalachian State Univ.),

(b) *Graduate Advisors:* Minze Stuiver (Quaternary Research Center/Geology) and Pieter Grootes (Quaternary Research) University of Washington.

(c) *Thesis Advisor Sponsor (1 grad; 2 undergrad; 4 high school):*

Graduates: Eric Butler, UVM Geology M.A. *Landscape Change in Shelburne*, 2004.

Undergraduates: Allison Brigham, UVM Education BA, *Final Project for EDSS course,* 2002; Jill Wagner, UVM Env. Studies BA, *Env. Education at Burlington High School,* 1997.

High School Students

Christian Fox, The Gailor School, *Making Geologic Maps*, 2002-2003;
Maggie Holmes, CVU High School, *Different learning styles to learn science,* 2002;
Kate Elvin, CVU High School, *Water levels in the Lake Champlain Basin,* 2001;
Katherine Meyer, CVU High Sch., *Science Learning for Middle Sch. Girls and Boys,* 1999.

Cathryn Allen Manduca, Evaluation Director

Science Education Resource Center, Carleton College
One North College Street, Northfield, MN 55057
Office phone: 507.646.4425
Email: cmanduca@carleton.edu

Professional Preparation

Williams College	Geology	B.A., 1980
California Institute of Technology	Geology	M.S., 1982
California Institute of Technology	Geology	Ph.D., 1988

Appointments

2002 -	Director, Science Education Resource Center
1999-2001	DLESE Outreach Coordinator
1994-2000	Coordinator, Keck Geology Consortium
1995-1997	Asst. Prof. of Science at Rochester Community College
1994	Asst. Prof. of Physics at St. Olaf College
1992-2001	Research Associate in Geology at Carleton College
1989-1992	Asst. Prof. of Geology at Carleton College

Publications ***Publications related to this project***

Fox, S., Manduca, C.A., Iverson, E. In press, Building Educational Portals atop Digital Libraries, Accepted for January issue of Dlib.

Manduca, C.A., Macdonald, R.H., Mogk, D., Tewksbury, B. 2004. On the Cutting Edge: Leadership development in the geosciences, published in Project Kaleidoscope Volume IV: What works, what matters, what lasts. July 23 issue: The work of disciplinary societies in identifying and nurturing faculty leaders. Available at http://pkal.org/template2.cfm?c_id=1364.

Manduca, CA., Mogk, D.W., and Stillings, N. 2003. Bringing Research on Learning to the Geosciences. Final report from Carleton College to the National Science Foundation, Grant # 0213165 [available online at http://serc.carleton.edu/research_on_learning/index.html].

Manduca, C.A., Mogk, D.W., Stillings,N., 2003 *Developing Collaborations Between Learning Scientists and Geoscience Educators*, Proceedings from the Fourth International Geoscience Education Conference, Calgary, Alberta, Canada

Manduca, C.A., Mogk, D.W. 2000. The Digital Library for Earth System Education: A Community Plan, Final report from the University of Oklahoma to the National Science Foundation, Grant #99-06648, 44 pp. [Available online at: http://www.dlese.org/documents/plans/index.html].

Other publications

Macdonald, R.H., Manduca, C.A., Mogk, D., Tewksbury, B. in review, Teaching Methods in Undergraduate Geoscience Courses: Results of the 2004 On the Cutting Edge Survey of U.S. Faculty, Journal of Geoscience Education

Macdonald, R.H., Manduca, C.A., Mogk, D., Tewksbury, B. 2005. On the Cutting Edge: Improving Learning by Enhancing Teaching in the Geosciences, AAAS.

Manduca, C.A., Mogk, D.W. 2003. Using Data in Undergraduate Science Classroom, Report from Carleton College to the National Science Foundation, Grant #0127298 [available online at: http://serc.carleton.edu/usingdata].

Manduca, C.A. 1996. Undergraduates Learning Science Through Research - The Keck Geology Consortium Undergraduate Research Program, Geotimes, v. 42, no. 10, p. 27-30.

Manduca, C.A., McMartin, F., Mogk, D.W. eds. 2001. The National SMETE Digital Library: Pathways to Progress, Report from UCAR to the National Science Foundation, Grant # 00-816100 [available online at: http://www.nsdl.org/community/documents.php].

Synergistic Activities

1. *NSDL and DLESE Committees*: DLESE Data Access Working Group (2000-); NSDL Community and Services Standing Committee (2002-); NSDL Coordinating Committee, Chair (2000-2001); DLESE Steering Committee, Chair (1999-2001), DLESE Annual Meeting, Program Chair (2001).
2. *Co-convenor of national geoscience education workshops and co-editor of proceedings including:* Teaching Geoscience with Visualizations (2004); Designing Effective Web-based Learning Resources (2003); Bringing Research on Learning to the Geosciences (2002); Teaching Quantitative Skills in a Geoscience Context (2002); Earth System Education Partnerships with Research Institutions (2001); Portal to the Future: A Digital Library for Earth System Education (1999); Spheres of Influence-Shaping the Future of Earth System Science Education (1996).
3. *Organization of workshops sessions at professional society meetings including:* Building Strong Geoscience Departments: Examples that Work (AGU, Fall 2003); Using Data to Teach Earth Processes: An Illustrated Community Discussion (GSA, Fall 2003); Towards a Better Understanding of the Complicated Earth: Insights from Geologic Research, Education, and Cognitive Science (GSA, Fall 2002); Enhancing Diversity in the Geosciences (AGU, Spring 2000); Digital Library for Earth System Education Workshop (AGU, Fall, 2000).
4. *Professional Society activities:* National Association of Geoscience Teachers: Distinguished Lecturer (2000-2001), National Officer (2001-2005), President (2003), Webmaster (2004-). American Geophysical Union: Excellence in Geophysical Education Prize (2004), Committee on Education and Human Resources (1998-2002, Chair 2004). Project Kaleidoscope: Networking Advisory Board (2002-), Sigma Xi: Education Advisory Council (1997-2001), Education Committee (2004-) Executive Committee (2000-2001, 1997-1998), Long Range Planning Committee (1996-1999).

Collaborators & Other Affiliations

Dave Fulker (UCAR), Mark Franzek (Central Michigan University), Laura Guertin (Pennsylvania State University, Delaware County), Michelle Hall (Science Education Solutions), Heather Macdonald (College of William and Mary), Mary Marlino (UCAR), Flora McMartin (University of California, Berkeley), Dorothy Merritts (Franklin & Marshall College), Bob MacKay (Clark College), Dave Mogk (Montana State University), Randall Richardson (University of Arizona), Martin Ruzek (USRA), Sam Patterson and Mary Savina (Carleton College), Jill Schneiderman (Vassar College), David Simpson (IRIS), Jim Slotta (University of California, Berkeley) John Snow (University of Oklahoma), Neil Stillings (Hampshire College) Tamara Sumner (University of Colorado), Rebecca Teed (Wright State University), Barbara Tversky (Stanford University), Basil Tikoff (University of Wisconsin), Barb Tewksbury (Hamilton College), Dan Barstow , Luann Dahlman, Tamara Ledley (TERC, Inc.), Paul Bierman and Christine Massey (Univeristy of Vermont).

Graduate Advisors: Leon T. Silver and Hugh P. Taylor, California Institute of Technology

Thesis Advisor and Postgraduate-Scholar Sponsor: None

SUMMARY PROPOSAL BUDGET

YEAR 1

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

ORGANIZATION
University of Vermont & State Agricultural College

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Paul R Bierman

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. **Paul R Bierman - none**	0.00	0.00	0.00	$ 0	$
2. **Christine A Massey - none**	0.50	0.00	0.00	1,437	
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)	0.50	0.00	0.00	1,437	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (1) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.75	0.00	0.00	2,650	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (1) OTHER				9,750	
TOTAL SALARIES AND WAGES (A + B)				13,837	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				2,415	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				16,252	
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				2,600	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				2,600	
H. TOTAL DIRECT COSTS (A THROUGH G)				18,852	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **community service rate (Rate: 29.9000, Base: 18852)**					
TOTAL INDIRECT COSTS (F&A)				5,637	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				24,489	
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)				$ 24,489	$

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

PI/PD NAME
Paul R Bierman

ORG. REP. NAME*

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

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

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

ORGANIZATION
University of Vermont & State Agricultural College

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Paul R Bierman

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. **Paul R Bierman - none**	0.00	0.00	0.00	$ 0	$
2. **Christine A Massey - none**	0.50	0.00	0.00	1,437	
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)	0.50	0.00	0.00	1,437	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.75	0.00	0.00	2,650	
3. (**0**) GRADUATE STUDENTS				0	
4. (**0**) UNDERGRADUATE STUDENTS				0	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (**1**) OTHER				9,750	
TOTAL SALARIES AND WAGES (A + B)				13,837	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				2,415	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				16,252	
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				2,600	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				2,600	
H. TOTAL DIRECT COSTS (A THROUGH G)				18,852	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				5,637	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				24,489	
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)				$ 24,489	$

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

PI/PD NAME
Paul R Bierman

ORG. REP. NAME*

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

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

Landscape Change Imagery: preparing a DLESE-ready and easily searchable resource

	Year 1 2005	Total 2003-2006
Salary		
Christine Massey, Co-investigator - project coordination UVM Education and Geology Departments salary 2 weeks over 1 year $34,496/12 months	1437	1437
Justin Henry, Educational Multimedia Developer - web page coding UVM Center for Teaching and Learning salary 3 weeks over 1 year $42,400/12 months	2650	2650
TOTAL SALARY	*4087*	*4087*
Wages		
Megan McGee, Temporary employee UVM Geology Department $13/hour; 750 hours	9750	*9750*
TOTAL STIPENDS	*9750*	*9750*
Benefits		
Faculty and staff 40.00%	1635	1635
Temporary employee 8%	780	*780*
TOTAL BENEFITS	*2415*	*2415*
CONSULTING SERVICES		
Dr. Cathryn Manduca and SERC, Carleton College Consultation regarding metadata and search structures NSF rate of $525/day; 4 days	2600	2600
TOTAL CONSULTING SERVICES	*2600*	*2600*
TOTAL DIRECT COSTS	18852	18852
TOTAL INDIRECT COSTS (public service rate, 29.9%)	5637	5637
TOTAL COSTS	24489	24489

BUDGEGT JUSTIFICATION

Salary – We request salary for two UVM employees who are associated with the *Landscape Change Program*. **CoI Christine Massey**, who has appointments both in the Geology Department and the College of Education, will oversee implementation of the search engine evaluation and interface with Manduca and the SERC. She will administer and collate responses to search engine user surveys and do primary, schematic design for the revised search engine. Massey has extensive experience managing web page development having done similar work for the extensive Perkins Geology Museum on-line archive (uvm.edu/perkins). We request 2 weeks of Massey's time for this work. **Justin Henry**, a programmer and multimedia developer at the University of Vermont's Center for Teaching and Learning, will perform the web development and coding to improve the search functions and allow better *Google*-type indexing. We have included 3 weeks of Justin's time (a little more than 100 hours) to ensure that resources are available for multiple revisions of the search engine in response to repeated and iterative user evaluation of search engine revisions. **PI Paul Bierman** will provide time as needed during the academic year amounting to less than 5% of his working hours. Bierman will supervise temporary employee McGee as she completes key-wording and image descriptions. In order to reduce proposal costs, he requests no salary support. Benefits are assigned at standard rates.

Wages – We request 750 hours of temporary employee wages for **Megan McGee,** who has worked with the *Landscape Change Program* for nearly two years. She will work describing and key-wording about 2700 images as well as checking metadata for the remaining ~7300 images in the archive.

Consulting Services – We will continue working with Carleton College's *Science Education Research Center* (SERC) and its director, Cathryn Manduca. Manduca is very familiar with the *Landscape Change Program* having led our external evaluation (April 2004) that included >30 people and provided detailed, extremely useful feedback for improving the project and its web site. This proposal, for improving finding aids in the archive, stems directly from findings of that evaluation. For this proposal, SERC personnel, including Manduca will serve as consultants assisting with the design of the new search and finding tools. Much of this work will be done remotely but we anticipate some of the work being done during either Manduca's visits to Vermont or Bierman and Massey's visits to SERC funded under the EMD grant. Thus, we request no travel support, only 4 days of consulting from the SERC at their standard rate which includes all overhead and benefits.

Indirect Costs – As is appropriate for this public service project, we have requested and been assigned an overhead rate of 29.9 percent.

Current and Pending Support

(See GPG Section II.C.2.h 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: **Paul Bierman**	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: **Eroding the Appalachians**

Source of Support: **NSF Geology**
Total Award Amount: $ **199,856** Total Award Period Covered: **06/01/03 - 05/30/06**
Location of Project: **eastern North America**
Person-Months Per Year Committed to the Project. Cal:**0.50** Acad: **0.00** Sumr: **0.50**

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

Project/Proposal Title: **Collaborative Research - Sediment Production and Alluvial Buffering in a Steepland River Basin: Waipaoa River Basin, New Zealand**

Source of Support: **NSF Geography**
Total Award Amount: $ **129,301** Total Award Period Covered: **08/01/03 - 07/30/06**
Location of Project: **New Zealand and Vermont**
Person-Months Per Year Committed to the Project. Cal:**0.50** Acad: **0.00** Sumr: **0.50**

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

Project/Proposal Title: **Quantifying Erosion and Sedimentation in Extreme Environments: refining and applying the cosmogenic method for Army-relevant landscape analysis**

Source of Support: **US DOD, DEPSCoR**
Total Award Amount: $ **757,808** Total Award Period Covered: **07/01/03 - 07/01/06**
Location of Project: **US, Panama**
Person-Months Per Year Committed to the Project. Cal:**1.00** Acad: **0.00** Sumr: **1.00**

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

Project/Proposal Title: **Cosmogenic Constraints on Sediment Generation and Transport, Namibian Rivers**

Source of Support: **NSF Hydrologic Sciences**
Total Award Amount: $ **59,539** Total Award Period Covered: **07/01/03 - 06/30/05**
Location of Project: **Vermont**
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: **Bringing Relevance to Earth Science Introductory Curricula through Images Showing Human/Landscape Interaction**

Source of Support: **NSF CCLI EMD**
Total Award Amount: $ **75,000** Total Award Period Covered: **03/15/05 - 12/30/06**
Location of Project: **Vermont**
Person-Months Per Year Committed to the Project. Cal:**0.50** Acad: **0.00** Summ: **0.50**

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*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.C.2.h 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: **Paul Bierman**	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: **Landscape Imagery: a catalyst for formal and informal science education**

Source of Support: **NSF Distinguished Teacher Scholar Award**

Total Award Amount: $ **300,000** Total Award Period Covered: **08/01/05 - 07/30/09**

Location of Project: **Vermont**

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

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

Project/Proposal Title: **Landscape Change Imagery: preparing a DLESE-ready and easily searchable resource-- THIS PROPOSAL**

Source of Support: **NSF**

Total Award Amount: $ **24,489** Total Award Period Covered: **06/01/05 - 05/30/06**

Location of Project: **Vermont**

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:

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.C.2.h 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: **Christine Massey**

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: **Landscape Change Imagery: preparing a DLESE-ready and easily searchable resource-- THIS PROPOSAL**

Source of Support: **NSF**

Total Award Amount: $ **24,489** Total Award Period Covered: **06/01/05 - 05/30/06**

Location of Project: **Vermont**

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: **Bringing Relevance to Earth Science Introductory Curricula through Images Showing Human/Landscape Interaction**

Source of Support: **NSF CCLI**

Total Award Amount: $ **75,000** Total Award Period Covered: **03/15/05 - 12/30/06**

Location of Project: **Vermont**

Person-Months Per Year Committed to the Project. Cal: **0.33** 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: 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: **Cathryn Manduca**

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

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

Project/Proposal Title: Collaborative Project: Combining Real and Virtual Professional Development for Current and Future Geoscience Faculty

Source of Support: NSF/DUE CCLI-ND

Total Award Amount: $673,188 Total Award Period Covered: 01/01/02 – 12/31/06

Location of Project: Carleton College

Person-Months Per Year Committed to the Project. Cal: 2.00 Acad: Sumr:

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

Project/Proposal Title: Linking Pedagogy, Resources, and Community Interaction to Support Entry-Level Undergraduate Geoscience Courses

Source of Support: NSF/DUE/NSDL

Total Award Amount: $600,000 Total Award Period Covered: 09/15/02 – 08/31/05

Location of Project: Carleton College

Person-Months Per Year Committed to the Project. Cal: 1.50 Acad: Sumr:

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

Project/Proposal Title: Collaborative Research: The DLESE Community Services Center

Source of Support: NSF/EAR

Total Award Amount: $570,830 Total Award Period Covered: 06/01/03 – 05/31/06

Location of Project: Carleton College

Person-Months Per Year Committed to the Project. Cal: 2.67 Acad: Sumr:

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

Project/Proposal Title: Collaborative Proposal: Geoscience Departments: Developing Pathways to Strong Programs for Tomorrow

Source of Support: NSF/GEO EAR

Total Award Amount: $128,020 Total Award Period Covered: 06/01/04 – 5/31/05

Location of Project: TERC

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

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

Project/Proposal Title: Faculty Participation in the NSDL – Lowering the Barriers (Univ. of Wisconsin – lead, subaward to SERC at Carleton)

Source of Support: NSF/DUE/NSDL

Total Award Amount: $88,381 Total Award Period Covered: 01/01/05 – 12/31/07

Location of Project: Univ. of Wisc. / Carleton College

Person-Months Per Year Committed to the Project. Cal: 1.00 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.

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: **Cathryn Manduca**	Other agencies (including NSF) to which this proposal has been/will be

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

Project/Proposal Title: DERMEED: Digital Educational Resources for Microbial Ecology, Evolution and Diversity (Montana St U lead, subawards to SERC/Carleton College)

Source of Support: NSF/NSDL

Total Award Amount: $30,000 Total Award Period Covered: 09/01/03-08/31/05

Location of Project: Carleton College

Person-Months Per Year Committed to the Project. Cal: 0.25 Acad: Sumr:

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

Project/Proposal Title: Bringing Relevance to the Introductory Curriculum Using Images of Human/Landscape Interaction

(University of Vermont lead, consulting contract to SERC at Carleton)

Source of Support: NSF/CCLI-EMD

Total Award Amount: $5,210 Total Award Period Covered: 04/01/05 – 03/31/07

Location of Project: Carleton College

Person-Months Per Year Committed to the Project. Cal: 0.20 Acad: Sumr:

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

Project/Proposal Title: "A Civil Action" – Using the Landmark Trial for Learning Environmental Geoscience and the Connection Between Geology and Human Health (Ohio St. U lead, subaward to SERC at Carleton)

Source of Support: NSF/CCLI EMD

Total Award Amount: $ 20,000 Total Award Period Covered: 04/01/05 – 03/31/08

Location of Project: Carleton College

Person-Months Per Year Committed to the Project. Cal: 0.05 Acad: Sumr:

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

Project/Proposal Title: Engaging the NAGT membership in creating web resources

Source of Support: NSF/GeoEd

Total Award Amount: $ 44,827 Total Award Period Covered: 05/01/05 – 04/30/07

Location of Project: Carleton College

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

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

Project/Proposal Title: Collaborative Research: Earth System Science in Cities- Assessing the Effectiveness of Using Data in Education (TERC lead, subaward to SERC at Carleton)

Source of Support: NSF/GeoEd

Total Award Amount: $ 26,543 Total Award Period Covered: 06/01/05- 05/31/07

Location of Project: Carleton College

Person-Months Per Year Committed to the Project. Cal: 0.25 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.

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: Cathryn Manduca	Other agencies (including NSF) to which this proposal has been/will be

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

Project/Proposal Title: Landscape Imagery: a catalyst for formal and informal science education (U. Vermont lead, subaward to SERC at Carleton)

Source of Support: NSF DTS

Total Award Amount: $ 31,142 Total Award Period Covered: 08/01/05 – 07/31/08

Location of Project: Carleton College

Person-Months Per Year Committed to the Project. Cal: 0.35 Acad: Sumr:

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

Project/Proposal Title: RUI: Impact and scalability of experiential summer science program for high school teachers and students

Source of Support: NSF IERI

Total Award Amount: $1,901,968 Total Award Period Covered: 10/01/05 – 09/30/10

Location of Project: Carleton College

Person-Months Per Year Committed to the Project. Cal: 1.10 Acad: Sumr:

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

Project/Proposal Title: Pedagogic Services for Digital Libraries

Source of Support: NSF NSDL

Total Award Amount: $724,959 Total Award Period Covered: 10/01/05-09/30/08

Location of Project: Carleton College

Person-Months Per Year Committed to the Project. Cal: 3.00 Acad: Sumr:

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

Project/Proposal Title: Collaborative Project: Portal to Research Information and Data for Education (PRIDE)
(TERC lead, subaward to SERC at Carleton)

Source of Support: NSF NSDL

Total Award Amount: $228,850 Total Award Period Covered: 09/01/05-08/31/08

Location of Project: Carleton College

Person-Months Per Year Committed to the Project. Cal: 2.00 Acad: Sumr:

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

Project/Proposal Title: Collaborative Research: Transforming ERESE into a high-impact cyberinfrastructure for teaching plate Tectonics in high and middle schools (UC-San Diego lead, Subaward to SERC at Carleton)

Source of Support: NSF NSDL

Total Award Amount: $38,122 Total Award Period Covered: 10/01/05 – 09/30/07

Location of Project: UC-SD / Carleton SERC

Person-Months Per Year Committed to the Project. Cal: 0.75 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.

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: Cathryn Manduca	Other agencies (including NSF) to which this proposal has been/will be

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

Project/Proposal Title: Earth Exploration Toolbook Workshops to Facilitate the Use of Earth Science Data in Education (TERC lead, Subaward to SERC at Carleton)

Source of Support: NSF NSDL

Total Award Amount: $57,368 Total Award Period Covered: 09/01/05-08/31/08

Location of Project: Carleton College

Person-Months Per Year Committed to the Project. Cal: 0.25 Acad: Sumr:

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

Project/Proposal Title: Collaborative Research: Microbial Life 2--Integrating People, Ideas, and Tools (Montana State University lead, Subaward to SERC at Carleton College)

Source of Support: NSF NSDL

Total Award Amount: $66,520 Total Award Period Covered: 11/1/05-10/31/07

Location of Project: Carleton College

Person-Months Per Year Committed to the Project. Cal: 0.25 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: Collaborative Research:

Source of Support:

Total Award Amount: Total Award Period Covered:

Location of Project:

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

Current and Pending Support

(See GPG Section II.C.2.h 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: **Cathryn Manduca**

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: **Landscape Change Imagery: preparing a DLESE-ready and easily searchable resource-- THIS PROPOSAL**

Source of Support: **NSF**

Total Award Amount: $ **24,489** Total Award Period Covered: **06/01/05 - 05/30/06**

Location of Project: **Vermont**

Person-Months Per Year Committed to the Project. Cal: **0.01** 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: 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.

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:

Clinical:

Animal:

Computer: **The Geology computer lab is equipped with 22 I-Macs installed in 2004. We have 5 portable Canon scanners and 4 Mega pixel digital cameras for image acquisition as well as three G4 PowerBook computers.**

Office: **Dedicated office and laboratory space is provided for graduate and undergraduate students in the new Geology building, commissioned in 2004, Delehanty Hall.**

Other: **The Center for Teaching and Learning's Digital Media Lab located in 407 Lafayette Hall, is a production facility that provides a full range of professional quality digital design, production, and cross-platform compatible delivery techniques.**

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

The Landscape Change Program image archive is housed on the UVM server cluster known as "zoo". It is backed up offsite nightly and maintained by the computing and information technology group. The Geology Department has four vans available for use by students to work in the field.

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.

The Science Education Resource Center, Carleton College, is an important partner for this initiative providing expert evaluation services for educational and web-based materials.