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

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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): ☐

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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.

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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.)

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

SUGGESTED REVIEWERS:
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REVIEWERS NOT TO INCLUDE:
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NSF 04-594 **02/09/05**

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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)

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☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Landscape Imagery: a catalyst for formal and informal science education**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **300,000**	**48** months	**08/01/05**	

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☐ 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.g.(iv).(c))
_____
☐ 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
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CO-PI/PD				
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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 ☒

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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**		**06/16/04**

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

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PROJECT SUMMARY

Landscape images are a powerful but underutilized tool for doing and teaching science. They provide a personal and human-scale linkage to geologic processes and the geography of place and time. This project will facilitate the widespread use of web-based landscape image archives to catalyze both formal and informal science education from K-12, to college, graduate school, and beyond. To accomplish this goal, we will build on five years of experience to create a toolbox of standards-compliant educational materials and catalyze a network of people from around the country to support each other in this endeavor of collecting and using landscape imagery to do and teach science. The work proposed here is based on the education, research, and outreach success of the *Landscape Change Program* (uvm.edu/perkins/landscape), a 10,000+ image archive that we have developed with NSF support (Bierman et al., 2005).

Over the next four years, we will *develop*, *demonstrate*, *evaluate*, and *disseminate* educational materials and ideas. *Development* will be done by students working in close concert with PI Bierman to create both image analysis and retrieval tools as well as web- and classroom-based educational materials, all centered on doing and learning science with landscape imagery. Teams of students, working summers, will *demonstrate* just how much science can be done by analyzing images quantitatively. Throughout the process, collaborator Manduca and the staff of the Science Education Research Center (Carleton College) will guide *evaluation* activity.

Dissemination is central to this project. We seek to catalyze the development of a national network of web-based landscape image archives and faculty interested in using such collections to teach both formally and informally. Central to this goal are teams of vested people (scientist, K-12 educator, technical or library staff). To bring together and intellectually equip such people, early on we will sponsor a national workshop in Vermont. Teams from around the country will learn from our experiences, share what they know, and begin a dialog that we anticipate will last for years. To refine best practices for working with K-12 teachers, Native Americans, and at-risk students, we will hold and evaluate a series of workshops locally. As the project matures, we will follow up with additional workshops at national meetings of educators, scientists, and digital librarians, publish in scholarly journals, and pursue other funding for synergistic informal science activities including writing a popular book and a preparing a traveling exhibit.

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. With our experience studying Earth's surface, developing educational materials, and using historic images to do and teach science, my students and I seek to change and improve the way people communicate landscape-scale science, particularly that involving the relationship between societies and the environment in which we live. 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.

Broader Impacts – By intimately integrating educational and discipline-based research activity, centered on understanding human-landscape interaction over time by means of historic images, we seek to model and disseminate a new paradigm for interdisciplinary, place-based education in natural science. This project will catalyze a national network of educators and web portals that will bring images, and the stories they tell about landscape-scale processes, to the classroom and to the broader community of life-long, informal science learners. 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. This project includes key roles for undergraduates, graduate students, and K-12 educators.

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.

PROJECT DESCRIPTION

The overarching goal of this project is straightforward. My students and I seek to facilitate the widespread use of landscape imagery to catalyze both science education and research activity across a variety of levels from K-12, to college, to graduate school and beyond. We seek to reach both formal and informal learners. By integrating educational and research activity, placed in the context of understanding human-landscape interaction over time by means of images, we will model and disseminate a national paradigm for interdisciplinary, place-based natural science (Bierman et al., 2005). Specific goals include:

- *catalyzing* the creation and use of landscape image archives for teaching and doing science,
- *demonstrating* the science that can be done using large numbers of searchable landscape images,
- *developing* and *evaluating* educational materials that use images as a catalyst for learning, and
- *refining* existing software and tools to help organize, find, and use landscape imagery.

Key to meeting the goals outlined above is the direct and continued involvement of K-12 educators, undergraduate, and graduate students in the process of doing science and creating and refining standards-compliant educational resources to be shared nationwide in the formal and informal science communities.

Human-landscape interaction and the importance of imagery -- For millennia, people have altered landscapes and landscape-scale forces have affected people. Alteration began with land clearance 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). The environmental movement used imagery of a flooded Grand Canyon (Nash, 1967) to bring these modern-day human impacts viscerally into the public eye (Fig. 1).

The role of images in teaching and doing interdisciplinary science -- Geoscientists are key providers of 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. Here, we advocate for a different approach. We argue that historical landscape images can be used to understand 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) – thus bridging the time gap between short-term instrumental records and geologic techniques more useful over longer timeframes. Using images is also a way to span disciplinary boundaries and interest people who view science as irrelevant or dull (Butler et al., 2003).

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

Figure 1. 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 the BLM in 1949) shows proposed location of Bridge Canyon dam and associated reservoir. The headline above topped the *New York Times* advertisement in which the image appeared on 6/9/1966.

Images as a way to do science -- Some of the earliest photographic documentation is that of G. K. Gilbert – the father of modern geomorphology – whose images show the dramatic shrinkage of alpine glaciers over the past century (Gilbert, 1904; Harrison, 1974). Using 115 years of images, Graf (1979) documents how clear-cuts triggered Colorado erosion. Meagher and Houston (1998) fathom ecological changes by comparing Yellowstone images before and after the 1988 fire while Webb (1996) investigates 100 years of change in the Grand Canyon using images of the Stanton expedition. Griffiths et al. (2004) analyzed 1300 scenes first photographed in the 1800s to calculate debris-flow recurrence intervals in the Grand Canyon and develop a model showing where flows originate. Science can be done with imagery!

Images as a way to teach science -- 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). However, reports 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). Such a disconnect between student perception and reality is not surprising when one considers 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 (Fig. 2). Open a textbook and examine the rivers chapter. You will find diagrams classifying stream morphology with little consideration of scale, no reference to time, and typically, few if any people. What a contrast to images we see in the media – flooded homes, buildings collapsing as banks erode, and livestock stranded by rising water -- images that present tangible links between Earth Science and the human condition.

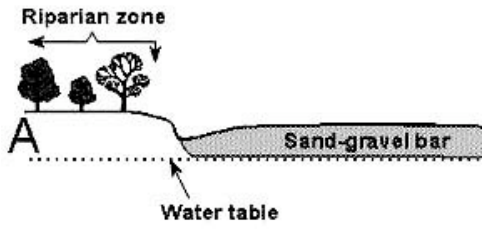

Figure 2. Compare these two images of a gravel bar. Static images similar to that on the LEFT can be found on many websites and in many textbooks; image from http://threeissues.sdsu.edu/. Such images represent schematically what is seen photographically in the RIGHT image from the *Landscape Change Program* archive (http://www.uvm.edu/perkins/landscape/LS_FullDisplayM.php?FN=LS02113_000.jpg). Here, there are people and action. The photograph is a catalyst for engaging discussions about the effects of logging and riparian buffers. Teaching both images gives the gravel bar meaning in a human context.

The Landscape Change Program – a springboard for action -- The NSF-funded *Landscape Change Program* is a catalyst for doing and teaching science using images. It is available free, on-line, at http://www.uvm.edu/perkins/landscape/. We now house more than 10,000 images, acquired from individuals and public archives, and see 20,000 to 40,000 individual hits per week from 1000 to 2000 unique IP addresses. The project provides researchers and students in the natural sciences 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). Over the past year, the program has grown explosively reflecting the success of a 2004 REU supplement

that supported three undergraduates (see case study, p. 5). Their work was presented at national GSA (Bierman et al., 2004a; Stanley Mann et al., 2004) and in a cover story for the April issue of *GSA Today* (Bierman et al., 2005) available as a preprint from http://www.uvm.edu/~pbierman/gsatoday.pdf

Work Plan -- Dissemination and outreach

Core to my life as an educator and scholar, is dissemination of what my students and I have learned.

National educators workshop – Our goal is to jump start new image archives. During the summer of 2006, we will hold a 3-day workshop in Vermont where teams of faculty, staff, and K-12 educators from across the United States will come together and catalyze the establishment of a national network of web-based image archives useful for doing and teaching science. There is significant national interest in such a workshop as indicated to us at conferences and by the letters of interest (see supplemental material for 22 letters from scientists in 17 different states). During the workshop, we will catalyze large and small group discussions with hands-on activities integral to image collection, description, and interpretation.

K-12 in-service and pre-service teacher workshops – This task seeks the best means of reaching K-12 educators so that they and their students use and learn from landscape imagery. We will hold four workshops, two during 2007 and two during 2008. Using evaluations of the first year's workshops, we will refine our approach before the second year. During workshops, teachers will work with the archive and we will focus on how activities we have developed can be used to meet a variety of Vermont State Educational Standards related to technology, presentation, the environment, and community service.

Workshops at professional meetings – Reaching out to other faculty is key. During the last year of the project, Bierman will offer workshops at national meetings of professional organizations including the Geological Society of America, the American Geophysical Union, the Association of American Geographers, the National Education Association, and the Digital Library for Earth Science Education.

Informal science education – The last five years have shown just how much landscape images excite and involve the community outside the University. Thus, we plan to focus significant resources toward ensuring broad dissemination of what we learn outside the traditional boundaries of academia. Reaching the informal science community is key to building not only an appreciation for science but for

Case Study From the Landscape Change Program – Erosion and the Tree Connection

REU student Michala Peabody suspected that more erosion would be recorded in deforested than in forested Vermont landscapes. To test this hypothesis, she searched the *Landscape Change Program* archive. Examining the 342 images in the archive that show erosion (Fig. 3A), 222 had no trees or almost no trees near the eroded site (65%). Conversely, only 9 images showing erosion had complete forest cover near the eroded site (3%). Her finding echoes contemporary studies done in the Northwest (Montgomery et al., 2000) and provides support for the suggestion, based on analysis of fan and lake sediment archives, that New England landscapes eroded rapidly in response to land clearance through the 19th century (Bierman et al., 1997; Jennings et al., 2003; Noren et al., 2002).

The distribution over time of images depicting erosion suggests the influence of major cultural transitions. The frequency of erosion images has three peaks (the 1860s, the 1920s, and the 1960s; Figure 3B). The earliest (1860s) is likely the result of clear-cutting for lumber. The steady rise in the frequency of erosion images, from 1900 to 1930, probably reflects the advent of the automobile and the road building and improvement that followed. The rapid rise in erosion frequency after 1960 and the slow decline thereafter reflects the massive disturbance occasioned by building the interstate highways (Fig. 3C, D).

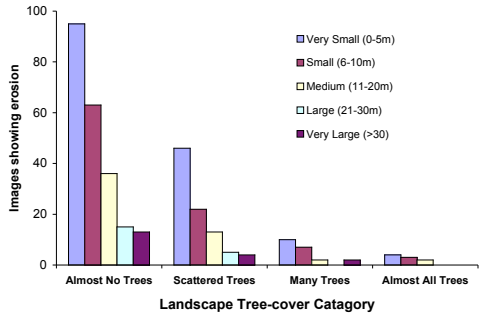

Figure 3A. Number of images showing erosion binned by tree cover category. Size of eroded area indicated by color. Erosion more commonly seen in images of treeless slopes.

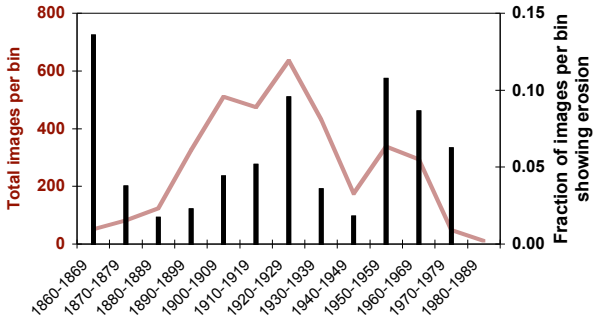

Figure 3B. Dated archive images (line) and fraction of images showing erosion (bars). Peaks related to deforestation (1860), road improvement (1900-1930), and interstate construction (1960-1980).

Figure 3C. Pre-construction image of interstate right-of-way with forested riparian corridor, May 1961.

Figure 3D. Same view as 3C, during interstate construction in October, 1961. Note scale of disturbance and riparian changes.

demonstrating to the public how science, and landscape imagery, can help inform policy decisions. Most important will remain the *Landscape Change Program* website, its newly spawned relatives elsewhere, and the interaction they occasion. Public involvement includes seeing, submitting, and commenting on images and learning from on-line modules, the number and topical coverage of which will increase dramatically during this project. Over the next four years, we will expand our efforts into new and broader channels. PI Bierman will work over his sabbatical leave (fall 2006) to write an image-rich book designed to illustrate for the general public how images can be used to inform scientific and environmental decisions. We have begun working with the Lake Champlain Science Center and UVM students to develop a traveling public exhibition that will use images from the archive to stimulate public discussion of controversial environmental issues such as highway expansion, sprawl, and clear cutting.

On-line course – Over the past year, PI Bierman has developed a 1-credit on-line course that guides student exploration of the *Landscape Change Program* and teaches Earth Science with images. He will continue to develop and teach this course as well as modify the course learning modules for other uses including workshops. Access to the course is available for reviewers of this proposal. Direct your browser to: http://webct.uvm.edu/ and enter "1pbierman" as both the login and password.

Home school workshops (experimental) – Almost a million children, 2% of the K-12 student body, are home schooled (http://nces.ed.gov/pubs2001/HomeSchool/) and not reached by traditional means of dissemination. We will hold a one-day workshop each year where parents of home-schooled children can learn to use the archive to do their own place-based education with standards-compliant resources we have developed. We will reach home schooling parents through the Vermont State Education Department.

Approaching at-risk students (experimental) – We suspect that hands-on activities, in our case those using landscape imagery, may be a particularly effective means of doing science and building an identity of place with both ethnically diverse and at-risk populations including rural, economically disadvantaged students. We will team with those resettling refugees in Burlington as well as work with UVM and Americorps staff working in economically disadvantaged schools across Vermont.

Native American landscape interpretation (experimental) -- We will team with an Abenaki middle school teacher and experienced workshop leader, Lynn Murphy, to work with representatives of the

Vermont Native American community with the goal of incorporating a completely different style and type of landscape description (her CV is included). The native culture uses stories for teaching with significant circularity and internal referencing. Western culture emphasizes the written word; native peoples communicate with an oral tradition. Murphy will organize two workshops of 6 people each. She will recruit Native Americans with knowledge and interest in landscapes and the stories they tell. Each participant will be given a digital voice recorder, thus respecting their 'gifting in exchange for knowledge' tradition. The Native American image descriptions will be presented on the web as audio files linked to images; they will be transcribed for searching and to provide access to those who are hearing-impaired.

Work Plan -- Educational Materials Development, the *Earth Surface Processes* Course

Over the next four years, I plan to continue exploring human-landscape interaction as a vehicle for teaching the fundamental tenets of geology and natural science by developing a new course (*Earth Surface Processes*) that uses such examples as a catalyst for learning. I intend for this course, and the materials and approach developed to teach it, to be an example disseminated widely via traditional routes as well as NSDL, DLESE, and SERC's *Cutting Edge* and *Starting Point* web sites. The course will be a platform for educational research about how students see and learn from images.

My experience over more than a decade teaching with images and disseminating materials from *Applied Geohydrology* at an upper level (Clapp et al., 1996; Gran et al., 1999; Nichols et al., 2003), *Earth Hazards* at an introductory level (Butler and Bierman, submitted; Butler et al., 2003), and my recently created on-line course (*The Changing Face of Vermont Landscapes*), suggests that such an approach will work well. Some of the research in this section (4 web-based learning modules) will be supported by an NSF-EMD pilot grant ($75,000) that will be funded for two years beginning March 15, 2005.

Course rationale -- Earth Surface Processes will be broadly focused at the second-level student, one who has taken introductory natural science and seeks to learn more. This student is often uncertain about career path but typically has great interest in learning more about the processes active at Earth's surface, particularly when such processes interact with people and society. The course will be broadly interdisciplinary, incorporating geology, geography, ecology, and history as well as technology (GPS,

digital imagery, surveying, chemical analysis) and the basic science (chemistry, physics, math) needed to make quantitative investigations. The rationale for this course is to have students early in their academic careers realize the importance and power of an interdisciplinary scientific method for approaching and solving vexing problems related to the interactions between people and the Earth on which they live. The courses will target undergraduate students who might major in geology, plant and soil science, botany, geography, natural resources, environmental science, and engineering. Our enrollment goal is 40 people.

Learning approaches and course content – Earth Surface Processes will include significant field, lab, and web-based pedagogies. The course will use in-class data exploration as well as individual and group projects to catalyze student learning about such topics as the physical and chemical properties of near-surface materials, the spatial and temporal distribution of erosion, the dynamics of moving water, and the impacts of weather and climate. The class will stress core competencies including numerical calculation, observation and description, and process-based understanding. It will directly incorporate disciplinary scholarship including that which my students and I have done under NSF support - massive prehistoric storms (Noren et al., 2002), human-induced erosion (Jennings et al., 2003), sediment budgets (Nichols et al., 2005), and the rate at which sediment is generated and rivers cut into rock (Reusser et al., 2004). Imagery, depicting landscapes and human/landscape interaction, will be a central to the course pedagogy. We will use the *Landscape Change Program* and image archives from other climatic and tectonic zones, extensively. Images will be used to train students in observation, to illustrate germane surface processes, to link physical and biological process, and as catalysts for original student research projects.

Course Development – In fall 2005, four web-based modules supported by the EMD grant will be integrated into my existing *Geomorphology* course along with several projects based on already-developed materials from the on-line class. The four modules will each include a pair of web-based, interactive tutorials – one taken before the relevant week or two of classes and the other after. Embedded in the web modules, will be student-transparent pre- and post-assessments so that we can understand what and how students have learned. In fall 2007, we will implement the entire new curriculum, evaluate it, and make revisions in time to offer the course again in fall 2008. During the summer of 2007, a graduate student will be supported full time to assist with course development. We will attempt to follow the

model that worked so well with previous course development (Butler and Bierman, submitted; Butler et al., 2003), funding a Masters in Teaching student who has an undergraduate Earth Science degree.

Work Plan -- Research Demonstration, Doing Science with Students and Images

One can do interesting and relevant science with images. We will continue the approach begun with three NSF-REU students in summer 2004 (Bierman et al., 2004a; Bierman et al., 2005; Stanley Mann et al., 2004). Over 10 weeks in the summers of 2006 and 2007, we will assemble teams of undergraduate and graduate students, trained both in technological skills and in image interpretation. They will work in archives gathering images in subjects, geographic areas, and time frames for which the current archive has less-than-optimal coverage. For the last several weeks of the summer, they will do quantitative image-based research and produce web modules showcasing their findings and the best images.

Value of image collection and data analysis -- The student-designed modules will demonstrate the intrinsic value of images as both research and learning tools. We view collection and analysis of such images as a catalyst for interdisciplinary education. The idea here is to make students major participants in the process of both knowledge discovery and the validation of a learning approach. Directly involving students in the image collection and interpretation process vests them in the program and its goals. Working day by day in archives handling historic images as well as uploading and describing those images has been our most successful means of bringing students into the process. The student-designed topical modules will be used by the public for easy, interpreted access to the archive collection.

Module topics – Student choice will determine module content but we hope to explore topics including: the history, technology, and environmental impacts of mining and quarrying, changes in the stature and health of high-altitude, boreal forests so well documented in 100+ years of images from Vermont's Green Mountain summits, the techniques and impacts of road building and its impacts on landscape and ecosystems over time, and the spatial and temporal distribution of tree species.

Work Plan -- Web Tool Development

Our goal is to use student expertise to enrich the archive software (developed under NSF EAR-0122005) by having students design, test, and implement a series of tools that facilitate both learning and

research using images. Once all tools are tested (end of summer 2006), they will be added to the archive web site. We decided several years ago to use open source, readily accessible software (MySQL and php) to create and display the archive. It seemed inappropriate to adopt proprietary software for a publicly-funded archive that had at the core of its mission, widespread distribution.

Specific tools -- Five years of experience as well as specific suggestions offered during a 30-person external program review in April 2004, suggest a variety of specific tools that would greatly enhance the educational and research value of image collections for both scientific and interdisciplinary study. For example, the ability to zoom-in on images allows details to be closely studied, the ability to spatially map image locations and do statistical analysis of keywords and descriptions can guide and enable quantitative studies, red/blue coding will allow 1880s stereoviews to be seen in 3^d, e-postcards and personal slide shows will increase site visibility, whereas improved searching and linking images to text, audio and other URLs will aid researchers. We view many of the 17 tasks we have identified as stand-alone student projects that can then be refined and integrated into the archive software as they are completed. Indeed, this part of our project is as much about student learning and involvement as it is software deployment.

Development process -- Development of new software tools will be overseen by a Senior Lecturer in the Computer Science Department at UVM, Robert Erickson (see CV), and done by computer science students with PI Bierman participating in an advisory role. During the fall of 2005, projects will be approached by groups of students in CS 192, *Independent Service and Teaching*, a programming course specifically focused on service learning. In the spring, students who enjoyed and excelled at this work, will be given the opportunity to work independently for credit (CS 195), to further refine software they created in the fall. During the summer of 2006, we have included full time support for one student to complete refinement and documentation of the software. Our goal is to build a team of students working together to solve real-world programming issues on a web-site that sees significant traffic and thus generates public exposure of their work. Our expectation is that the students will focus on programming rather than interface graphics and design. Thus, we have included limited support for a professional graphic designer associated with UVM's *Center for Teaching and Learning*, to polish the students' work and make sure it is consistent with the look and feel of the remainder of the site. By developing and

refining tools with undergraduate students rather than simply employing programming staff, we directly combine applied research and tool development into a meaningful, student-centered learning experience.

Intellectual Merit -- This project is grounded in the successes we and others have had engaging students through place-based and visually-centered learning. Our 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. We will focus on visualizations and expand our linkages with 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 5 years, they have established and improved the *Landscape Change Program,* a unique searchable archive of landscape imagery. 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 and a variety of pre-service and in-service programs. The UVM *Center for Teaching and Learning* and its *TechCats* have worked with faculty to develop dozens of courses and hundreds of web pages. Together, we bring to this project energy, enthusiasm, and the desire to fundamentally change how science is taught and done at many levels (Table 1).

Broader Impacts -- This work has significant broader impacts. Using and understanding images requires crossing boundaries that separate students and scholars in geology, geography, ecology, and history. Through the *Landscape Change Program* site and other sites catalyzed with this award, we will bring the scholarly work of academia directly into the local and national community; this is informal science education one image at a time as pictures and their captions spill over the internet to communities everywhere. Our last five years of work have shown us that people of all ages have an intrinsic interest in images. We seek to catalyze change and inform the public, providing raw data for major environmental and societal decisions through the visceral impact of imagery. Most work will be done by students deeply vested in the program. This pervasive integration of educational and research activities, a hallmark of Bierman's career and of the *Landscape Change Program*, will serve as a model for faculty far and wide.

TABLE 1. Project Design - Landscape Imagery: a catalyst for formal and informal science education

	National Dissemination	Educational Material Development	Research Demonstration - Science	Web Tool Development
Goals	Catalyze creation and use of image archives for teaching science and interdisciplinary studies throughout the US. Develop and refine effective means to recruit and train K-16 educators in image use and value-added data acquisition. Promote informal science education and informed decision making.	Model creation of a second-level class for undergraduates that uses imagery to allow students to understand fundamental Earth surface processes in the context of physical, chemical, biotic and human interactions. Provide tested tools and curriculum for others to adopt.	Demonstrate the variety and utility of science that can be done when undergraduates and graduate students gather images then use such images to do and interpret for the public quantitative, interdisciplinary natural science.	Have computer science students in a service learning arrangement augment existing software to improve the ability of a wide range of users (K-16 and informal science) to find images and use those images both to learn about and do natural science and interdisciplinary studies.
Specific Tasks	Hold workshop for teams of University faculty, staff, and K-12 teachers from around the US to catalyze archive creation. Hold workshops for Vermont K-12 teachers in order to determine best practices for such involvement. Hold workshops at national and regional meetings of geologic, geographic, and education societies. Write informal science book, design public exhibit, publish scholarly articles. Determine best practices to reach home-school, at-risk, and Native American populations.	Design, test and refine web-based modules introducing and summarizing major topics. Create, test, and refine relevant field and laboratory exercises using landscape images as a catalyst.	Gather images from repositories and use them and the existing image archive to do and interpret for the informal science learner quantitative landscape scale science. Produce web-based summary modules of techniques and findings as demonstration of research and research-training outcomes. Post these on Landscape Change web site so people have easy access to the most instructive images.	Refine search and image to image linking capability, add zoom function. Provide GIS-based mapping on the fly. Add user specific scrap-book capability and e-postcards. Detailed, readable software documentation.
Specific Outcomes	Nationalization of effort by creation, in different physiographic regions, of image archives optimized for doing natural science. Best practices identified for involving K-12 educators and students in the process. Broad dissemination of both informal and formal science findings and approach.	Freely available and tested classroom and field curriculum augmented by weekly web-based, image-centered modules that introduce and review specific topics.	Case studies highlighting the type of quantitative research and research training that can be done with archives of landscape imagery. Document the process of collection and creation so others can benefit.	Establish set of tested web-based tools for image analysis and finding, reviewed by others and incorporated in open source, documented software available free of charge to others interested in setting up image archives. Excite and engage students with "real world" programming tasks.
Participants	Teams of University faculty, K-12 teachers, technical staff from regions across the U.S., K-12 teachers and students from Vermont, Native Americans, staff member Massey, PI Bierman	PI Bierman and a graduate student working with undergraduates in classroom and field settings, Manduca and SERC.	Undergraduate and graduate students working with PI Bierman, staff member Massey, and external reviewer Webb.	Computer Science students, Lecturer Erickson, PI Bierman, UVM TechCats and CTL staff, members of the public and academic community, Manduca and SERC.
Evaluation	Evaluate workshop effectiveness in terms of delivery and outcomes by tracking creation of new archives and by involvement of high school teachers and their students.	Evaluate modules for learning value. How students learn from images. Track students after taking class.	External peer review and refinement of research, research methods, and research training.	Initial site usability review at UVM, second usability review after tool revision followed by tool refinement
Time Frame	Years 2, 3, and 4	Years 2, 3, and 4 - primary support from NSF EMD grant to Bierman and Massey	Years 2 and 3	Year 1
Resources Needed	Travel, lodging, and support for workshops, equipment stipends for K-12 teachers, outreach support.	Graduate student summer stipends; evaluation by Manduca and SERC.	Summer student stipends. Support for Massey to process and check image data.	Lecturer, Student, TechCat and computer staff salary, repeated, iterative usability evaluation by Manduca and SERC.

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Ph.D., 1993, Geology, University of Washington, Seattle, WA with A. Gillespie
"*Cosmogenic Isotopes and the Evolution of Granitic Landforms*"
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

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

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(ii) 5 most significant publications,

Bierman, P. R. and Nichols, K.K. (2004) Rock to sediment - Slope to sea with ^{10}Be - Rates of landscape change, **Ann. Review of Earth Science**. v. 32. p. 215–255

Reusser, L., Bierman, P.R., Pavich, M., Zen, E., Larsen, J., and Finkel, R. (2004) Rapid Late Pleistocene Incision of Atlantic Passive-Margin River Gorges, **SCIENCE**, v. 305, 409-502

Noren, A., Bierman, P.R., Steig, E., Lini, A., and Southon, J., (2002), Millennial scale storminess variability in the northeastern United States during the Holocene epoch, **NATURE**, v. 419, 821-824.

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(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

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Education

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Master of Science - Management Information Systems. Analyst work: resort operations, banking operations.

Castleton State College, Castleton, Vermont May 1987
Bachelor of Science - Computer Information Systems. Minor in Business Administration.

Professional Experience

University of Vermont Burlington, Vermont Aug 1991 - present
Senior Lecturer -- Instruct students in various computer courses. Currently working on a service learning option for several of my courses. Course topics include word-processing, spreadsheets, database, programming, History of Computers and World Wide Web Design. Software includes: Visual Basic, Java, JavaScript, ASP, PHP, HTML, Pascal, UNIX, DOS, Windows. Students range from first year, seniors, to adults in continuing education. Class size averages 40 students. Courses include:

* CS 008 (048): Introduction to World Wide Web Design
* CS 014: Introduction to Visual Basic Programming
* BSAD 040: Information Technology and Management
* CS 042: Dynamic Data
* CS 095: Teaching in Computer Science
* CS 148: Database Design with Web Applications
* CS 192: Independent Service and Teaching
* CS 195: Java Development
* CS 195: Database Design
* CS 195: Internship
* CS 294: World Wide Web and Database Design
* CS 295: Database Internship
* CS 295: World Wide Web Design

Clarkson University, Potsdam, New York Aug 1990 - May 1991
Teaching Assistant -- Served as *Director of MIS Computer Lab* in charge of 25 PC computers serving the graduate students as well as undergraduates. Instructed, graded, advised and tested students in computer concepts, word processing, spreadsheets, electronic mail, data flow diagramming, SQL, database design, Harvard Graphics, UNIX, VM/CMS, DOS.

Projects

Cold Regions Research Lab, Hanover, New Hampshire 2001 - Present
Graphical Interface for Snow Models, Creating a graphical interface (Visual Basic) for various Fortran programs used to model the melting conditions of snow for flood damage control.

Community Development and Applied Economics, UVM Winter 2000
Community/Business matching program, Task is to finish, debug and improve a visual basic program that they will be using to match communities and business together.

Wyeth Nutritionals , Georgia, Vermont Winter 1999
Assay Program, Worked with several chemists in redesigning a program to input data to perform regression analysis using absorbance and concentration amounts read by a machine from test tubes. A Visual Basic Program has completely automated the calculations as the input numbers have been entered.

Professional Programs, Continuing Education, UVM, Burlington, Vermont 1998
Database Implementation Worked with the Professional Program staff to implement a database system for keeping track of the programs offered and timelines for the programs.

Bruggers Bagels, Burlington, Vermont Fall 1995
Internship Creation Worked with the MIS manager to develop an internship program for students. Documented the current polling process for the company and developed a manual for use by interns over the coming semesters. Worked with MLINK Polling, OMRON polling and Excelnet Polling software, Paradox database systems both DOS and windows versions.

Maple Research Center, Proctor Station Fall 1994
Spreadsheet Design Worked with a programmer and user in converting a FORTRAN program into a spreadsheet program. The goal of the program was to provide the Research Center with production cost analysis of producing maple syrup.

Air Mouse Corporation, Williston, Vermont July 1993 - Aug 1993
Menu Design Worked with a team to design and build the menu structure for interactive television. Utilized Visual Basic as the main design aid. An interesting short term project that provided me with an insight of some of the things to come.

Ellen Roscoe Iverson, Evaluation Specialist

Science Education Resource Center
Carleton College, One North College Street
Northfield, MN 55057
Phone 507-646-5749
eiverson@carleton.edu

Professional Preparation

University of Minnesota, Scientific and Technical Communications, B.S. 1989
University of Minnesota, College of Architecture, Environmental Design, B.S. 1989
University of Minnesota, Scientific and Technical Communications, M.S. 1993

Appointments

Web Development and Evaluation, Carleton College (March 2003-present)
Technology Manager, Marathon Multimedia (April 2000-March 2003)
Operations Manager, Marathon Multimedia (June 1996-April 2000)
Technical Assistant to 3rd line Manager/Staff Programmer, IBM (August 1989-June 1996)

Synergistic Activities

Co-Evaluator "On the Cutting Edge" NSF (Grant DUE-0127310).
Member of NSDL Educational Impact and Evaluation committee including participation in the meetings and NSDL Evaluation Education Impact Workshop (October 2003)

Publications

Manduca, C., Iverson, E., Fox, S., McMartin (submitted) "Motivating and Supporting Faculty Use of Educational Digital Libraries: An Example from the Geosciences." Joint Conference on Digital Libraries

Fox, S., Manduca, C.M., Iverson, E. (2005) "Building Education Portals atop Digital Libraries." *D-Lib.*

Manduca, Merritts, Savina, Iverson (2004) "Starting Point: Harnessing pedagogy with geoscience teaching resources" Poster for NSDL 2004 Annual Meeting

Manduca, Mogk, Fox, Kirk, Iverson(2004) "Using Data in the Classroom" Poster for NSDL 2004 Annual Meeting

C. Manduca, S. Fox, J. McDaris, E. Iverson(2004)"Fostering Effective Geoscience Teaching,": Poster for NSDL Reusability and Interoperability Workshop.

Iverson, Ellen Roscoe (2003), "The Starting Point Project: Moving Beyond Usability and Web Logs to Refine Evaluation" NSDL Evaluation Education Impact Workshops

Manduca, C.A., Fox, S., Iverson, E., MacKay, B. (2003), "Promoting Change in Undergraduate Geoscience Education-Examples from SERC" Poster for Broadening DLESE Annual Meeting

Roscoe Iverson, E. (1994), "Producing a Multimedia Product -- Design Phase" Proceedings for the Society for Technical Communicators 41st Annual Conference, Minneapolis.

Roscoe Iverson (1994), "InfoSeek: Creating a lexicon for information search engine" IBM Technical Disclosure Bulletin (in lieu of patent).

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

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.

Lynn K. Murphy, Native American Outreach Coordinator

895 Pike Hill Road
Corinth, Vermont 05039
(802) 439-6621 (home)
(802) 439-5534 (work) and (802) 439-6444 (fax)
Lmurphy@wrvs.us or lkm49@iwon.com

Academic Degrees:

Dartmouth College, 1996 - Present - Candidate for MA in Cultural Studies: All coursework completed - Thesis in progress.

University of Central Florida - 1992-1995 - B.S. in Science Education, Minor in Biology.

Seminole Community College, 1991-1992 - A.A. - Summa Cum Laude

Licensure:

Vermont Teachers License in Science, Grades 7-12 - Highly Qualified as defined by the State of Vermont and NCLB. 1997-Present

Vermont Teachers License in Social Studies, Grades 7-12 – Highly Qualified as defined by the State of Vermont and NCLB. (1998-Present)

Educational Appointments and Service:

Middle School Science Teacher at Waits River Valley School from 1997 to Present. Teaching Integrated Science to 7th & 8th grade.

On the Curriculum Committee for Science at Orange East Supervisory Union. (2003-2005)

Advisor, speaker and participant at Historic Deerfield for the tri-Centennial of the "Deerfield Massacre" working both with Historic Deerfield and the Pocumtuc Valley Memorial Association (PVMA) on the exhibits and as an advisor to the website developed during this historic occasion. My family was featured in the exhibit.

Invited to present at the *Beyond Difference Conference* in 2004 Organized by the Vermont Center for the Book.

Trainer for the *Jason Project* in Vermont (an exemplary 4-8 science Curriculum - 2000 to present)

Trainer for Teachers Workshops run by Vermont Folklife Center focusing on awareness of the continued presence of Native Americans in Vermont in conjunction with the educational film developed by the Folklife Center. (2003 - 2004)

Guest speaker at Symposium on Abenaki's in Vermont, St. Michaels College - 2004.

Assistant teacher at Governor's Institute, Science and Technology strand, 2004

Professional Memberships:

Member of National Science Teachers Association since 1998.
Member of National Educators Association and Vermont NEA.
Past Member of AISES (American Indians in Science and Engineering Society).

Honors and Awards:

Recipient of Vermont Institute of Natural Science grant 2002 for development of salmon hatching in our classroom - participated in this program with the Federal Dept. of Fish and Wildlife and VINS for the past4 years. This has been a very successful program involving all 7th grade students each year.
Woodrow Wilson Teacher Leadership Fellowship in Biology - 2000.
Awarded membership in Phi Kappa Phi Honor Society in 1993
Awarded membership in Kappa Delta Pi Honor Society in 1994
Awarded Minority Students Scholarship and Certificate of Academic Achievement for Academic Excellence
Deans List many times during the 4 years that I was an undergraduate.

Other Pertinent Experience:

One year as a Science Educator at the Orlando Science Center.
Worked in the private sector for over 20 years as a Para-professional Accountant, Contracts Administrator, and Assistant. During the time that I worked in the private sector I taught workshops to various office personnel in the use of specific software packages all over the country as requested by the home office of the PM Group (my employers).

Personal Information:

Lynn K. Murphy, Born 11/21/1950 in Cambridge, Massachusetts.
Married, one daughter, Melissa Ann Murphy, born 4/9/1988
Native American Descent

Shelley F. Snyder, K-12 Teacher Trainer

Mt. Abraham Union High School, Bristol, Vermont 05443
TEL: 802-453-2333, E-Mail: ssnyder@mtabe.k12.vt.us

EDUCATION AND CERTIFICATION

Certificate of Advanced Study in Educational Leadership, University of Vermont, May 2001
Professional Educator's License: Mathematics, Science, and Middle Level (math and science)
St. Michael's College; M. Ed. May 1987
University of Vermont; B.A. Geology 1978

RELEVANT EXPERIENCE

2004 to present: University of Vermont PDS On Site Coordinator, MAUHS
2003 National Association of Geoscience Teachers Outstanding Earth Science Teacher
2002 Spring Semester taught one half of the Special Methods for Science Teachers at Mt. Abraham
1990 to present: Supervised student teachers and interns for University of Vermont
1991 to present: Teacher, high school math and science, Mt. Abraham UHS
1997 to present: Adjunct Instructor in the Department of Education of the University of Vermont
1997 and 1999 to 2001: President, Vermont Geological Society
1999 to 2000: Master Teacher for NSF Grant with University of Vermont
Brought Recognition to school through numerous publications
1999, Pilot Test teacher for River Chapter for textbook EarthCom, American Geologic Institute Publication,
Participated in activities that enhanced school leadership promoted and collegial work through workshops and publications:
Geological Society of America
American Geological Institute
Ocean Arks International
Lewis Creek Association
New England Intercollegiate Geological Conference
New England League of Middle Schools
1989 to 2001: Designed and implemented numerous grants
Grow Vermont Agriculture in the Classroom
Living Machines, Artificial Stream Model
Collaborative Arts Project
Building Toothpick Bridges
New Haven River Project
Math Through Games
1988 to 1991: Teacher, seventh grade mathematics, Mt. Abraham UHS
1991 and 1994: Governor's Institute on Science and Technology, summer.
Wrote Curriculum for Seventh Grade Mathematics, Mt. Abraham UHS, 1991.
1981 Wrote Curriculum for Champlain College, summer camp, 1987. Course title: Searching the
Seas and the Stars, a 32-hour hands on course covering geology, limnology, and astronomy, target age was 12 to 16 year olds.
1978 to 1981: Water Resources Research Center, conducted chemical and biological analysis, managed lab, supervised and taught procedures to support staff and students.

ACTIVITIES

Foundations for Excellent Schools, Mt. Abraham committee member, 2001.
Principal Search Committee, 1999 and 2001.
Horizon Advisory Committee, 2001 to present
Visioning Committee, 2001 to present
Action Plan Committee, 1999 to present.
Coach/School Coordinator for Odyssey of the Mind, 1988 to 1991.
Faculty advisor for Thin Budget Productions, student run thespian group, 1994 to present.
Instructional Support Team member, 1997-8, 1993-5.

PUBLICATIONS

1. Student River Monitoring and Citizenship: A curriculum Unit", produced by Lewis Creek Association in collaboration with Mt. Abraham Union High School and others.
2. Geologic Field Trip Sites for Teachers in Northwestern Vermont", in Guidebook to Field Trips in Vermont and Adjacent Regions of New Hampshire and Vermont, New England Intercollegiate Geological Conference, October 1, 2, and 3, 1999, with Christine Massey.
3. Curriculum development for Ocean Arks International to support living machine technology, June, 1999.
4. Marine Biology on Science Street". ANESU Teaching and Learning Newsletter. p. 3. May 1993
5. Guest Editor, Green Mountain Geologist, fall 1992. Vermont Geological Society Newsletter. The Value of Field Trips in the study of Science". Green Mountain Geologist. p. 14, fall 1992.
6. The New Haven River Project". Leading and Learning. Pp. 46-47. 1991
7. Fossil of the Quarter", regular column in the Green Mountain Geologist, Vermont Geological Society Newsletter.
8. Land Treatment of Wastewater in Dover, Vermont". with A. E. Cassell, D. Meals and S. Illenye, Lake Champlain Basin Environmental Conference, 1980.
9. In Support of Fresh Water Origin of Barren Zones in the Southern Champlain Sea". Abstract, Green Mountain Geologist, spring 1977.

PRESENTATIONS

Presenter for Geological Society of America: 13 March 2001, Crystal Growth Under The Microscope, an interactive presentation.
Presenter, Best Practices Conference, Vermont Technical College, 29 March 2000.
Presenter: "Maps in the Middle", Vermont Association for Middle Level Education, Oct. 1994, Shelburne Middle School.
New Haven River Project, 10th Conference, New England League of Middle Schools, 1991.

Budget Justification

Faculty and Staff Salary – We request salary for 2 faculty and 2 staff. PI Bierman's summer salary will allow him to dedicate large amounts of time to designing and implementing the national workshop during the summer of 2006, working with students in archives and doing quantitative image-based science during the summers of 2007 and 2008, developing the new class during the summer of 2008, and writing papers for journals while revising class materials during the last summer, 2009. Bierman's experience with the NSF-REU students during the summer of 2004, suggests how important it is for him to spend 8 to 10 hours a day with the students in archives scanning images right beside them and doing one-on-one mentoring as their projects develop. The payoff of such intense mentoring is clear - the students presented at the GSA national meeting, authored a lead article for GSA Today where their data are featured (April 2005), and added >7000 images to the archive. Several weeks of summer salary will support Senior Lecturer, Computer Science Department, Robert Erickson. During the first summer, Erickson will spend a week understanding the current code driving the web site and designing student projects. During the second summer, he will supervise the computer science student doing the final changes to the site and writing the software documentation. Outreach coordinator Massey (who has been associated with the *Landscape Change Program* since its inception) will be supported part-time (30%) for the first three years of the project. During the first year, she will be responsible for the logistics needed to run both the web-site evaluation workshops and the national workshop. During the second and third years of the project, she will lead the outreach efforts for at-risk and refugee populations working one on one and in groups both training staff and working with groups. She will work with teachers Murphy and Snyder to coordinate and help deliver pre-service, in-service, and Native American workshops. During the second and third summers of the project, Massey will be responsible for doing quality control and the final processing of images collected by the students. Massey and Bierman will run one-day workshops for home-schooling parents. Massey will organize these workshops. During the first and second years of the project, there are modest amounts of salary (2 weeks total) allocated to a professional graphic designer from the *Center from Teaching and Learning* primarily to do html coding and ensure that the look and feel of student-developed web pages matches and indeed enhances that of the existing site. Standard benefit rates are assigned to faculty and staff salaries.

Teacher Stipends – Modest stipends will support two teachers to run workshops. Shelly Snyder, an established high-school teacher who has worked with the *Landscape Change Program* for five years, will work with Outreach Coordinator and Education Specialist Massey to design and run the four, in-service and pre-service workshops (each two days long) during years 2 and 3 of the project. Snyder will receive a $1500 stipend for her work. She is very well-equipped to do this work, having spent six weeks in the summer of 2004 collecting imagery alongside the REU students and having used the *Landscape Change Program* in her classroom for the past five years. Middle-school teacher and Native American, Lynn Murphy will work with Outreach Coordinator Massey and PI Bierman to develop and deliver two, one-day workshops for Native Americans during years 2 and 3 of this project. Murphy is an experienced workshop leader, having delivered numerous workshops for the Jason and Folklife programs. She is very well connected within the Native American community. Murphy will receive a $750 stipend for her work.

Student Support – Significant funding is directed toward student support because our prior experience shows that employing students over the summer is the best catalyst we have for deeply vesting them in the program and ensuring that they are a critical part of the creation of new resources and knowledge. The students have been and will continue to be the core research engine of the *Landscape Change Program*. We request two summers of student support. Each summer the project will support 2 Masters and 2 undergraduate students. The students will be recruited from geology, geography, environmental science, education, and natural resources programs both at UVM and from nearby schools (Middlebury, Dartmouth, Plattsburg State, and

the Vermont State Colleges). One Masters in Education or Teaching student will work full time for a summer with Bierman gathering resources and designing class activities for the Earth Surface Process course. The other students will work together in teams of four (2007, 2 MS, 2 undergrads) and three (2008, 1 MS, 2 undergrads) for 10 weeks each summer collecting, describing, uploading, and doing science with landscape images – a model that works well based on the success of our REU supplement during the summer of 2004. Our REU experience suggests that the students will spend a total of about two weeks scanning images, about four weeks describing them including doing detailed key wording and image narration, and the remaining month doing quantitative image analysis and preparation of a module for professional review (see letter from R. Webb) and presentation on the web-site. We expect that many students will travel to a professional meeting with PI Bierman and present their results. We have budgeted for this travel during years two and three. An exceptional computer science student will be supported during the summer of 2006 to work closely with Computer Science Lecturer Erickson, PI Bierman, and a professional graphic artist from the *Center for Teaching and Learning* to finalize the implementation and documentation of the new software modules. This student will work full time for 12 weeks and will be part of the national workshop at summer's end. This work will provide deep immersion in the processes of software development and implementation as well as dissemination at a national level – a unique experience for an undergraduate. Hourly wages will support undergraduate *TechCats*, skilled Computer Science students trained and employed by the *Center for Teaching and Learning*. These students will assist in the formatting and debugging of new web pages and may very well be the same students who did the initial design work as part of the service learning course in the fall of 2005. We view these funds and the *TechCats* as a flexible source of programming and graphics support to approach a wide variety of technical issues as they arise over the first two years of the project.

Supplies – Supplies will support the training of teachers and Native American collaborators as well as the acquisition of additional images. Three I-books will replace three very well used PowerBooks that have run the program since they were purchased in early 2002. The computers will be used during the academic year for outreach efforts by coordinator Massey as well as teachers Murphy and Snyder. During the summer, they will be used by students to scan and describe imagery. We have recently purchased scanners that should remain useful through the duration of the project. Economical GPS units and digital cameras will be purchased and distributed to teachers attending in-service workshops rather than providing stipends. Finding where archive photos were taken and rephotographing these sites is an integral part of how the *Landscape Change Program* has been integrated into classrooms. Since both the GPS and digital camera are tools are necessary to acquire such data, our rational is that by providing the tools during training, we not only compensate teachers for their time but also provide an inducement to stay in the program using technology they have become familiar with during the workshop. Similarly, we will distribute digital voice recorders to participants in the Native American workshops. As explained in the work plan, the generation of audio descriptions is fundamental to our approach and the use of digital recorders allows rapid translation of such narratives onto the web. We suspect by distributing the recorders and with continued follow-up by Murphy, audio descriptions will continue to be added to the archive long after the workshops have ended.

Travel – Travel is an important part of the dissemination efforts we will undertake. The national workshop is the largest single cost. We plan to support the attendance of 40 people from around the United States including full support for two keynote speakers (USGS Scientist, Robert Webb and OSU Landscape historian, Ronald Doel). For each other attendee, we will offer up to $300 for travel to Vermont and provide lodging and food for four nights and three days. Our cost estimate assumes $40/day for food (3 days), $30/night for accommodation on campus (4 nights), as well as $20 (two trips) a person for bus or van travel during the workshop (visiting archives, working in the field rephotographing historic images). This is a total average cost per person of $560 although we realize that the keynote speakers will cost more and some local participants

will cost less. It is difficult to estimate actual numbers of attendees. This proposal includes letters of interest and support from 20 people (as well as 2 from keynote speakers) of which several would likely come alone. For the others, we estimate an average attendance per institution of 2 people because we suspect that not everyone will be able bring with them a K-12 teacher in addition to a faculty member or technical person (either library science or computer oriented). We anticipate using the new Geology Department building and computer facilities for the workshop. The workshop will be held over a weekend to ensure lower airfares. Local workshop costs are substantially less. One-day pre-service and Native American workshops require only the provision of lunch and snacks for which we budgeted $15 per person assuming 15 people per year (9 pre-service teachers and 6 Native Americans). The two-day in-service workshops are budgeted assuming that 10 teachers per year will attend and will be housed on the UVM campus for one night ($30). Food (snacks, two lunches, a dinner and a breakfast) will be catered on campus for $70/person. We will reimburse for mileage and parking and estimate the average cost at $50/person. For the two web-site evaluation workshops, each of which will last a day, we anticipate inviting 5 people from Vermont, covering their mileage and parking as well as feeding them snacks and lunch. We estimate that the per-person cost will be $60. Limited travel costs are provided for project participants including the students, the PI and outreach coordinator. We request miles during years two and three for PI Bierman and students to travel back and forth from archives to scan images as well as miles for outreach coordinator Massey to work with at-risk students and their teachers in northeastern Vermont. Travel to national meetings during years two and three is requested so that students and PI Bierman can present their results. During year four, we expect to disseminate results and run workshops at national meetings and so request travel support for Bierman to attend two meetings. For evaluation activities, we request airfare and food for travel between Vermont and Minnesota. During year one, we expect that Manduca will travel to Vermont twice to lead the web evaluation workshops. During year three, Massey and Bierman will travel to Minnesota to meet with Manduca and SERC staff to evaluate educational materials. We ask only for food and plane fare since family members in the respective cities will provide lodging.

Evaluation and educational research – Evaluation and educational research are a critical part of this project. To ensure that both evaluation and educational research are done well and thoroughly, we will work closely with Cathryn Manduca and Ellen Iverson of Carleton College's *Science Education Research Center* – a leading organization in the reform of science education. This work will be supported in part by a UVM subcontract to Carleton that will facilitate several visits between institutions as well as professional experimental design, creation of evaluation instruments, bringing together face-to-face focus groups, and collaboration in the presentation and publication of educational research findings. The investment in evaluation will have large paybacks. Detailed, iterative evaluation and improvement of the *Landscape Change Program* website will help us and others understand better the target audience of such image archives as well as how people in that audience respond to and interact with archive websites. Lessons learned in Vermont will be transferred during the national workshop to others from around the country improving many other web sites as well. As pointed out in Manduca's subcontract commitment letter (supplemental material), we know that images are a critical part of learning for natural scientists, but we have limited understanding of how this learning occurs; indeed, we know little about how such images are actually perceived by students. Designing and implementing an experimental protocol for understanding what natural science students see in landscape images and how that "seeing" affects their learning are fundamental and important topics in educational research. Together, with SERC, we will evaluate image-rich portions of PI Bierman's on-line and face-to-face classes to understand better how students are learning. This knowledge, critical to others teaching with images, will be disseminated in a variety of forums by Manduca and Bierman including professional meetings, workshops, and refereed publications.

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: **Looking Forward -- Scaling Up The Digital Image Archive of Landscape Change**

Source of Support: **NSF GeoEducation**
Total Award Amount: $ **113,619** Total Award Period Covered: **09/01/01 - 02/28/05**
Location of Project: **Vermont**
Person-Months Per Year Committed to the Project. Cal:**0.50** Acad:**0.00** Summ:**0.50**

*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: **Acquisition of ICP for Research and Research Training**

Source of Support: **NSF Equipment and Facilities**
Total Award Amount: $ **126,000** Total Award Period Covered: **02/27/02 - 02/27/05**
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** Sumr: **0.50**

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

Project/Proposal Title: **Landscape Imagery: a catalyst for formal and informal science education -- THIS PROPOSAL**

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:

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.

SUPPLEMENTARY MATERIALS

1. SUMMARY TABLE AND LETTERS OF SUPPORT AND COMMITMENT FROM INDIVIDUALS INTERESTED IN LANDSCAPE CHANGE AND NATIONAL WORKSHOP

2. LETTER OF COMMITMENT AND SUBCONTRACT AGREEMENT FOR EVALUATION BY CATHRYN MANDUCA OF SCIENCE EDUCATION RESOURCE CENTER

SUPPLEMENTAL MATERIALS -- LETTERS DECLARING SUPPORT AND WORKSHOP INTEREST

Name	Affiliation	Position	Type of Institution	Geographic area	Interest
Henry Art	Williams College	Professor	Small liberal arts colllege	Massachussetts	Environmental Studies and Biology
Daniel Bain	USGS, Menlo Park	Postdoctoral Scientist	Government	California	Geology
Wally Bothner	University of New Hampshire	Professor	Research university	New Hampshire	Geology
Douglas Clark	Western Washington University	Professor	Research university	Washington	Geology and Education
Clifford E. Clark, Jr.	Carleton College	Professor	Small liberal arts colllege	Minnesota	History and Environmental Studies
Weecha Crawford	Bryn Mawr College	Professor	Small liberal arts colllege	Pennsylvainia	Geology
Joanna Curran	Texas State University	Professor	State university	Texas	Geography
P. Thompson Davis	Bentley College	Professor	Business college	Maine	Geology
Ronald Doel*	Oregon State University	Professor	Research university	Oregon	History and Geology
Martin Doyle	University of North Carolina	Professor	Research university	North Carolina	Geography
David A. Franzi	Plattsburg State	Professor	State university	New York	Geology and Environmental Science
James Garmen	Salve Regina University	Professor	Private university	Rhode Island	Archeology and Historic Preservation
Robert B. Jacobson	USGS	Staff Scientist	Government	Missouri	Hydrologist and Environmental Research
Frank Magilligan	Dartmouth College	Professor	Small liberal arts colllege	New Hampshire	Geography and Hydrology
Laura Mallard	Appalachian State University	Lecturer	Small state college	North Carolina	Geology
Dorothy Merritts	Franklin and Marshall College	Professor	Small liberal arts colllege	Pennsylvainia	Geology and Environmental Science
Andrew J. Miller	University of Maryland	Professor	Research university	Maryland	Dept. of Geography & Environmental Systems
Kyle Nichols	Skidmore College	Professor	Small liberal arts colllege	New York	Geology
Mary Savina	Carleton College	Professor	Small liberal arts colllege	Minnesota	Geology, Envronmental Studies
William Slattery	Wright State University	Professor	State university	Ohio	Geology and Teacher Education
Robert Webb*^	USGS	Staff Scientist	Government	Arizona	Geology and Hydrology
Ellen Wohl	Colorado State University	Professor	Research university	Colorado	Geology and Hydrology

^ = external science reviewer
* = workshop keynote speaker

UNIVERSITY of NEW HAMPSHIRE

College of Engineering & Physical Sciences
Department of Earth Sciences
Durham, New Hampshire 03824-3589
(603) 862-1718 Fax: (603) 862-2649
e-mail: earth.sciences@unh.edu

January 21, 2005

Dr. Paul R. Bierman
Department of Geology
University of Vermont
Burlington, VT 05405

Dear Paul:

Congratulations on your invitation to submit a proposal to the NSF Distinguished Teacher Scholar Program. I have read the Project Summary and am very aware of your past efforts to use landscape images, past and present, to evaluate landform development, examine anthropogenic changes, and to assess real and potential geohazards. I happily endorse your proposal.

It is my intention this term to use some of the images you have already archived in our introductory Environmental Geology class. To the best of my knowledge, although none of the images now available for web-use are from New Hampshire, there are sufficient similarities in our parts of New England that our students will be able to make some important comparisons as a potential independent project. (I suspect we might have a few Vermonters in class who might just want a project closer to home).

I think a number of us at the University of New Hampshire (faculty and students in Earth Sciences, Natural Resources, Geography, and History, for example), NH Department of Environmental Services (including the State Geological Survey), and State and town historical societies will be interested participants in the planned workshops over the next several years if your proposal is successful. I hope very much it is and will expand into New Hampshire and elsewhere.

I look forward to attending one or more of the workshops.

Sincerely yours,

Wally Bothner

Wallace A. Bothner
Professor of Geology

Texas State University | SAN MARCOS

Department of Geography

601 University Drive
San Marcos, Texas 78666-4616
phone: 512.245.2170
fax: 512.245.8353
email: geography@txstate.edu
www.geo.txstate.edu

February 4, 2005

Paul R. Bierman
Department of Geology and Natural Resources
University of Vermont

Dr. Beirman,
Thank you for taking the time to familiarize me with your proposed project making use of landscape images in geoscience education. I understand that this is the NSF proposal, "Old Landscape Images and the Quantification of Landscape Change through Time" being submitted to the NSF Director's Award for Distinguished Teaching Scholars. If this proposal is funded, I am definitely interested in taking part in the planned workshops.

I have been using historic landscape photos to some extent in my recent and on-going research. I focus on fluvial geomorphology, particularly the response of a channel to long-term changes. My research group at Texas State University has accumulated enough photos to quantify changes in channel morphology as a result of dam building, and we are currently investigating the changes due to urbanization and changes in land use within a watershed. Historic photos provide the information necessary to make these projects successful.

I have introduced students to the use of aerial photos in a limited way in my Introduction to Physical Geography course. This is a lower-level undergraduate course, and the photos help them understand how the landscape of Texas may change due to events far away. In particular, photos have been useful to illustrate how Saharan dust may reach around the globe. Historic photos of the central Texas area have been particularly useful, because the majority of the students identify with local development. Seeing the change in landscape documented through historic photos is becoming an increasingly essential tool in teaching physical geography.

As much as I am interested in using landscape photography in both research and teaching, I have only been able to integrate it in a minimal fashion. The work proposed by Paul R. Bierman, Jehanna Howe, Elizabeth Stanley-Mann, Michala Peabody, Jens Hilke, and Christine A. Massey will provide the tools I need to more fully integrate the use of landscape photos. Having directly observed the increase in student understanding as a result of showing them photos of change, I believe this will become a greater part of reaching undergraduate and graduate students in the geosciences in the future, as well as a research tool needed for quantifying and understanding the response of a landscape to external factors of change.

Sincerely,
Joanna C. Curran
Assistant Professor
Texas State University
San Marcos, TX 78666

Colorado State University
Knowledge to Go Places

Department of Geosciences
1482 Campus Delivery
Fort Collins, Colorado 80523-1482
(970) 491-5661
FAX: (970) 491-6307
www.cnr.colostate.edu/geo/

Paul Bierman
Professor of Geology and Natural Resources
University of Vermont
Burlington, VT 05405

Dear Paul: 24 January 2005

I am very interested in your proposal to develop workshops focused on using historic images as tools for learning about and doing science. I have used a variety of historic and contemporary landscape images in my research, my teaching, and my books and lectures aimed at informing the general public about human effects on river ecosystems (e.g. *Virtual Rivers*, 2001, Yale University Press; *Disconnected Rivers*, 2004, Yale University Press). I would welcome the opportunity to participate in the workshops and image repositories that you propose to develop.

Sincerely,

Ellen Wohl

Ellen Wohl
Professor of Geology
Department of Geosciences
Colorado State University
Ft. Collins, CO 80523

THE UNIVERSITY OF NORTH CAROLINA
AT
CHAPEL HILL

February, 4, 2005

Professor Paul Bierman
Department of Geology
University of Vermont, VT 05405

Dear Paul:

I am writing to support your proposed educational program for landscape imaging and processing. Landscape images form the foundation of most introductory and advanced physical geography, geology, and general environmental science courses. I would anticipate using this image database for my introductory physical geography course, which enrolls ~ 400-500 students per year at University of North Carolina. As such, developing a usable database of these images, particularly with emphasis on landscape changes through time, would be particularly valuable in developing courses and in teaching courses for a wide range of audiences.

I am whole-heartedly supportive of this idea, and look forward to participating in it should it be funded.

Best regards,

Martin W. Doyle
Assistant Professor

Martin W. Doyle
Department of Geography, University of North Carolina, Chapel Hill NC 27599-3220
Phone: 919-962-3876, Fax: 919-962-1537, Email: mwdoyle@email.unc.edu

SALVE
REGINA
UNIVERSITY

2 February 2005

Professor Paul Bierman
Geology Department
University of Vermont
Burlington, VT 05405-0122

Dear Professor Bierman,

Please consider this letter as enthusiastic support for your application to the National Science Foundation. As coordinator of the Cultural and Historical Preservation program at Salve Regina University, I am very eager to initiate a landscape change program covering Rhode Island. The opportunity to participate in the training activities described in your proposal would be of tremendous help in getting the program going.

Located in Newport, Rhode Island, Salve Regina University is an independent institution in the Catholic tradition of education, providing higher education to women and men. The university offers Associate, Baccalaureate, and Master's degrees, the Certificate of Advanced Graduate Study, and the Ph.D. in Humanities. Salve Regina enrolls 2,300 men and women from 34 states and 17 foreign countries and boasts over 14,000 alumni and alumnae. Our Cultural and Historic Preservation program enrolls approximately 40 faculty, and is staffed by two full-time permanent faculty and one half-time lecturer,

Faculty and students from our Cultural and Historic Preservation program have a real need for the program, both to supplement their own scholarship and teaching and to disseminate results of those activities to the public. Following your model, we would partner with local archives and private collectors to produce the database. While we imagine that our interest would be a little different - we are especially concerned with human-wrought changes to the built environment over time – we feel that this might be an interesting cross-disciplinary complement to the original program.

Thank you for considering us for participation in the program. Please don't hesitate to call me or e-mail me if you require any additional information. I wish you the best of luck with the grant application, and look forward to further discussions.

Sincerely,

James C. Garman, Ph.D
Assistant Professor, Archaeology
Coordinator, CHP Program

From: Cliff Clark <cclark@carleton.edu>
Date: January 24, 2005 3:33:28 PM EST
To: Paul Bierman <Paul.Bierman@uvm.edu>
Subject: Re: your email to mary savina

January 23, 2005

To Whom It May Concern:

I write in enthusiastic support for the application of Professor Paul Bierman's for and NSF Director's Award for Distinguished Teacher Scholars (DTS) to disseminate information from his NSF Landscape Change Program. I teach American History but I am very interested in introducing the connections between the history of the environment and the process of settlement and industrial development in the nineteenth century. My book, "The American Family Home," (University of North Carolina Press, 1986) focused on popular house types and their relationship to the ideal of what a good family should be. I traced the changes in house design and compared that to the images of the ideal family that were portrayed in the popular press. My current interest expands on the concept of the built environment to examine the process by which communities grow and change spatially over time. I have been working for the past decade on the history of Bennington, Vermont, using maps to chart its spatial growth as a mill town. Hence, Paul Bierman's interest in recovering images of the landscape and making them available to students and scholars is of major interest to me as a way of tracking environmental change historically. I support his project because it would appeal to historians like myself as well as to geologists.

Sincerely,

Clifford E. Clark, Jr.
Professor of History and M.A. & A.D. Hulings Professor of American Studies

Appalachian
STATE UNIVERSITY

Department of Geology
ASU Box 32067
Boone, NC 28608-2067
(828) 262-3049
FAX (828) 262-6503

January 27, 2005

Dr. Paul Bierman
Department of Geology
University of Vermont
Burlington, VT 05401

Dear Dr. Bierman,
I am excited to learn of the new programs coming out of the Landscape Change Project at UVM. As outreach coordinator for the LCP in its early days, I was continuously surprised by the variety and quality of images that were found by us and the participating students around Vermont. With support from the NFS Distinguished Teacher Scholar Program, your ability to provide workshops to interested participants would be invaluable.

The geology department at Appalachian State University encourages its faculty to develop and participate in educational outreach programs. It would be a great opportunity to bring the Landscape Change Project south.

Our involvement in the Landscape Change Project would benefit this community and our departmental outreach and education program as we develop our new geology museum at ASU. This region of the southern Appalachians is known for its amazing mountain views, the Blue Ridge Parkway, ski resorts, and unfortunate amount of mining, quarries, and rampant development. An archive of the magnitude that your team has developed in Vermont would be a true educational resource for North Carolina.

Best regards,

Laura Mallard

Laura Mallard
Instructor of Geology

FRANKLIN & MARSHALL

January 30, 2005

Paul R. Bierman
Professor of Geology and Natural Resources
University of Vermont
Burlington, VT 05405

Dear Dr. Bierman:

Congratulations for the acceptance of your letter of intent for the NSF Director's Award for Distinguished Teaching Scholars (DTS). I wrote an initial letter of recommendation for you in that first round, and at the time I considered you to have an excellent chance at the DTS award. Your intensive efforts in teaching, research, and educational outreach already have garnered you much respect and recognition, and you are deserving of such a prestigious award. Furthermore, your plan to foster a national network of people who will support each other in this new endeavor of historic landscape image collection for science and teaching is timely and important. I am delighted to have the possible opportunity to be involved in workshops for this effort.

You are aware that I have been working with Dr. Robert Walter, also on the faculty at Franklin & Marshall College, to investigate the impact of Early American milling and mill dams on the landscape and waterways of the Appalachian Piedmont region. The impact of Early American mill dams on stream dynamics, sediment storage, and sediment transport has not been explored by the geomorphic community, and yet tens of thousands of post-settlement mill dams altered the flow of water and sediment in streams throughout the Atlantic Piedmont. In the Conestoga watershed of Lancaster County, Pennsylvania, large volumes of hill slope soil (~57 to 124 million m^3) were eroded and trapped in at least two hundred 18^{th} and 19^{th} Century mill-dam reservoirs that occupied its 1037 km of streams. And yet, few people seem to recognize the tremendous changes in the landscape both prior to the milling era (~1700 to 1900), or since then with widespread urbanization, much of which is occurring on what now are sediment-filled mill ponds.

The relevance of our work to your DTS project is great. For example, one of our study sites—now a golf course and country club—has extreme problems with stream-bank erosion and enlisted our efforts as geologists. We discovered that an early-20^{th} century photo shows a small mill pond immediately downstream of the golf course. Upon further investigation, we found historic maps of the area in the Lancaster County Historical Society archives. It turns out that the entire valley bottom, over a distance of several km, had filled with sediment over a period of two centuries, from ~1700 to 1900. While interviewing elderly residents in the region, we were shown photographs of barren landscapes, with no trees in sight. The same areas today are wooded, the once-ubiquitous mill ponds are filled with sediment, and suburbanites dealing with

problems of channel downcutting, bank erosion, and flooding struggle to fix the problem, blaming it solely on stormwater runoff.

It is our experience that the images have the most powerful impact, for us as well as for those with whom we try to communicate the importance of understanding the cumulative, centennial-scale impact of land-use change. Bob and I have applied for NSF and other funding to support our research, and plan to devote the next 10 years to investigating the impact of mill dams on erosion, sediment transport, sediment storage, and high modern sediment yields.

We now are expanding our study area into other parts of the Appalachian Piedmont, including in Maryland, where early classic studies in geomorphology pondered the origin of widespread, low alluvial terraces. Just as in Lancaster County, we now are discovering a rich database of historic photos of mills, mill ponds, and treeless landscapes for these areas. We are working closely with the Lancaster County Historical Society, and the director of the museum would be one of our team members for your DTS workshops. The third member from the K-12 education community is not yet chosen, but we know many in the local educational community, and it will be easy to select someone to work with us.

I wish you the best of luck for this project, and thank you for considering us as part of your project.

Regards,

Dr. Dorothy Merritts,
Professor, Department of Earth and Environment

January 31, 2005

Professor Paul Bierman
Department of Geology and Natural Resources
University of Vermont
Burlington, VT 05405

Dear Paul:

I am pleased to write this letter in support of your proposal to the NSF Distinguished Teacher Scholar program. The concept of developing image repositories for reconstruction of change over time is an intriguing and valuable one.
My personal interest is in stream channel change and floodplain evolution in response either to extreme floods or to landscape perturbations induced by human activity. Many channel/floodplain systems (particularly in urban areas, but also in agricultural landscapes) are heavily modified and the kind of historical documentary evidence you describe may serve as a crucial resource in the effort to track the extent and timing of alteration. The current focus on river restoration, often using simplified versions of geomorphic relationships derived in the 1950's and 60's, would benefit from some historical perspective in that many river channel/floodplain systems are far from natural and their current configuration is often a legacy of historical change rather than strictly a reflection of the contemporary flow and sediment transport regime.

I would welcome the opportunity to participate in a workshop to learn more about how to develop a landscape image repository. This would be particularly useful in connection with our anticipated submission of a proposal to NSF this spring for a Hydrologic Observatory encompassing the Potomac River basin and western shore Chesapeake Bay drainage. Because of the rich land-use history in our study area, development of such an archive could provide important supporting data for interpretation of past and present landscape pattern over a range of geomorphic settings. If your proposal and our project are both funded I can foresee a productive collaboration that could have substantial benefits for both research and education.

Sincerely,

Andrew J. Miller
UMBC Dept. of Geography & Environmental Systems

WILLIAMS COLLEGE WILLIAMSTOWN, MASSACHUSETTS 01267

Henry W. Art
Director, Center for Environmental Studies &
Samuel Fessenden Clarke Professor of Biology
4 Kellogg House

(413) 597-2461
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email: HART@williams.edu

2 February 2005

Dr. Paul R. Bierman
Professor of Geology and Natural Resources
University of Vermont
Burlington, VT 05405

Dear Dr. Bierman,

The Williams College Center for Environmental Studies salutes your initiatives in establishing the Landscape Change Program at University of Vermont and making your techniques accessible to national educational and public communities through workshops that would be held in Vermont. We are very interested in collaborating and cooperating with you in these endeavors. For the past 35 years we have been conducting landscape-scale research on the impacts of human activities on the biotic communities of the Berkshires, and the interpretation of historic photographs is becoming an essential technique to gather data on past landscapes. Recently we have initiated several contentdm sites { http://contentdm.williams.edu/} for the public display of our growing collection of landscape images of the Hopkins Memorial Forest and the region.

Please interpret this letter as both an indication of support for your proposal to NSF and an expression of our desire to participate in any way that you feel would be constructive. All the best to you in this project.

Henry W. Art

United States Department of the Interior
GEOLOGICAL SURVEY

Water Resources Division
345 Middlefield Rd./MS 420
Menlo Park, CA 94025
January 28, 2005

Dr. Paul R. Bierman
Department of Geology
University of Vermont
Burlington, VT 05405

Dear Paul,

I am writing to strongly endorse your NSF Distinguished Teacher Scholar Award proposal to disseminate your *Landscape Change Program* to academic/research programs across the U.S. I recognize the importance and power of your proposed work, as I recently completed my dissertation work on landscape change in the Baltimore, MD area. Throughout this process I repeatedly ran across old images that crystallized the abstract, historical landscape better than reams of data. These images generated the most enthusiasm from the widest range of audience members in lectures and presentations. Though my role as a graduate student did not allow me to formally catalog and serve these images, I vowed to work toward this goal once I had an established professional position. As it happens, you have begun this cataloging remarkably well for Vermont and are ready to bring the rest of us along.

The power of historic photos and the general public's interest in them is obvious. The number of picture postcards that are sold on eBay for generous sums everyday is incredible. David Rumsey's digitized map collection has made him a web celebrity. The power of what you are proposing is that it taps this interest in history and the local and uses it to invigorate interest in landscape science. Landscape science is usually lumped with earth science in K-12 curricula, and earth science is too often reserved for students deemed unprepared for biology, chemistry, or physics. However, landscape science is a complicated field that challenges the keenest of minds. Moreover, understanding the landscape is fundamental to human survival, whether it is a taboo against building in landslide prone areas or precision agricultural production. Not only does your proposed work enhance "big" scientific inquiry, it builds tools to allow society to think like a landscape.

I am currently in a post-doctoral position with the USGS. I think professionals like those working at the USGS would be eager to contribute to the work you are proposing, especially in their public outreach role (e.g., imagine the response a region specific landscape change kiosk would get when incorporated into displays at professional meetings or state fairs). Moreover, I am actively seeking permanent employment and plan on continuing my study of landscape history in future positions. Documenting landscape change with historical photography will be a part of my research and teaching. Participation in proposed workshops would allow landscape scientists to share the photographs and the information contained therein with the public and allied professionals more effectively. I look forward to the opportunity.

Cordially,

Daniel J. Bain
NRC Post-Doctoral Fellow

United States Department of the Interior

U. S. GEOLOGICAL SURVEY

Columbia Environmental Research Center
4200 New Haven Road
Columbia, Missouri 65201

February 2, 2005

Dr. Paul Bierman
Geology Department
University of Vermont
Burlington, VT 05405

Dear Paul,

I am writing this letter in support of your proposal to the National Science Foundation Distinguished Teacher Scholar Program (NSF 04-594). I think it is a great idea to spread the understanding of how to put together landscape imagery projects. Presented in an interpreted context, landscape imagery can be a compelling link between citizens and the landscapes they inhabit.

Since seeing your success with the University of Vermont Landscape Change Program (uvm.edu/perkins/landscape) I have discussed implementing the concept in several other areas in the mid-continent. For example, the historical landscape perspective appears to be a very useful vehicle for connecting stakeholders with river resources – it delivers the historical context and allows the public to appreciate the rapidity of environmental change. Certainly, the workshops you propose would be an efficient mechanism to indoctrinate educators and resource managers in the intricacies of developing these programs. If this grant is funded I would be able to recommend a half dozen or so people from the Midwest who would be interested in participating and applying the knowledge to issues like river management, environmental history, and resource development.

Please feel free to share this letter. I strongly support this valuable project. Your track record in similar endeavors speaks well for success in this one.

Best Regards,

Robert B. Jacobson, Ph.D.
Research Hydrologist

Plattsburgh
STATE UNIVERSITY OF NEW YORK

CENTER FOR EARTH AND ENVIRONMENTAL SCIENCE
102 Hudson Hall

101 Broad Street
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3 February 2005

David A. Franzi
CEES, SUNY Plattsburgh
101 Broad Street
Plattsburgh, NY 12901

Paul R. Bierman
Geology and Natural Resources
University of Vermont
Burlington, VT 05405

Dear Paul;

Thank you for your email that outlines your proposal for developing image databases to document and teach about historical landscape change. I am well aware of the fine work that you and your students have done documenting historical landscape changes in Vermont and the project you propose seems like an excellent way to encourage others to follow similar lines of research and pedagogy. I am particularly interested in the great potential for applying local place-based learning to a better understanding of anthropogenic forcing of landscape change. Should the opportunity arise, I would be very interested in participating in a workshop and would work toward building an image database for the northeastern Adirondack and northwestern Champlain Valley region. I know of several local people, including historians, high-school teachers, and librarians who would enthusiastically embrace a project of this nature.

I think your proposal has great merit and I wish you the best of luck. Please keep me in mind should you receive funding.

Sincerely,

Dave Franzi

Department of Geology
Bryn Mawr College
101 North Merion Avenue
Bryn Mawr, PA 19010-2899
215-526-5115

BRYN MAWR

January 18, 2005

Paul R. Bierman
Professor of Geology and Natural Resources
University of Vermont
Burlington, VT 05405

Dear Paul:

I am so very pleased to hear of your plans to spread your landscape scale image repository ideas and expertise to others who have similar interests and enthusiasm. I have considered doing this for some time for various parts of Pennsylvania. We are engaged in a GIS initiative here in the 5 counties around and including Philadelphia, with a focus on our area along the 'Main Line'. There are a number of historical groups in this vicinity and I have planned to engage them in developing exactly such a repository. In addition to the suburbs, other areas of the state that have changed their landscape significantly include the coal mining regions that we have visited frequently on field trips. I keep trying to visualize those areas when they were entirely deforested to provide mine timbers. Finally, along the same lines, although not strictly landscape, I have a colleague much interested in documenting architecture over time. The kind of repository you have developed for landscapes would also work perfectly for that it seems to me.

So, this is a strong letter of support, and a commitment to become involved however I can. If there is funding to come and learn from you I would definitely come and could bring my architect friend and possibly a local historical person. It sounds very exciting and the kind of thing that I will soon have time for as I leave active teaching.

Yours truly,

Maria Luisa Crawford
Chairman

WRIGHT STATE
UNIVERSITY

Department of Geological Sciences
3640 Colonel Glenn Hwy.
Dayton, OH 45435-0001
(937) 775-3455
FAX (937) 775-3462
www.wright.edu/geology

January 28, 2005

Paul R. Bierman
Professor of Geology and Natural Resources
University of Vermont
Burlington, VT 05405

Dear Professor Bierman,

I have read with great interest your proposal titled: Landscape Imagery: a Catalyst for Formal and Informal Science Education. This project would build an important element of learning and would be useful and aligned with ongoing science education efforts at Wright State University.

If I can be of any assistance to you please contact me.

Cordially,

William Slattery

William Slattery
Associate Professor
Departments of Geological Sciences
And Teacher Education

United States Department of the Interior

U.S. GEOLOGICAL SURVEY

520 North Park Avenue
Tucson, AZ 85719
(520) 670-6671 ext 238 / Fax 670-5592

February 3, 2005

Paul Bierman
Department of Geology and Natural Resources
University of Vermont
Perkins Hall, Colchester Avenue
Burlington, VT 05405

Dear Paul:

I am writing this letter to express my support for your proposal being submitted to the National Science Foundation - Distinguished Teacher Scholar program and to commit to helping you with two aspects of the project. As you know, I have several decades of experience and publications using images to document landscape change. My work and that of my colleagues has approached a variety of important geomorphic and ecologic topics using thousands of images, both originals and later rephotography to document such varied processes as the change in debris fan size, river channel morphology, and riparian vegetation density over time. We have worked all over the desert southwest, from the Mojave Desert and Grand Canyon to the northern Colorado Plateau and the Sonoran Desert.

I am aware of your work in New England with the *Landscape Change Program* and know that with this proposal you wish to disseminate the techniques you have employed to a wider audience as well as do a variety of scientific projects with students. As part of your project, you will be holding a national workshop in Vermont during the summer of 2006. I gladly agree to be a keynote speaker and participant in that workshop where I will review the science we have done with landscape imagery and work with others helping them to develop their own image archives and research methodologies. Since I am a USGS employee, I cannot be compensated but accept your offer to cover my travel expenses.

I know that during the summers of 2007 and 2008, you will have interdisciplinary teams of students and K-12 teachers working to acquire images and do research projects based on such images. As part of the project's evaluation protocol and for the benefit of the students and teachers involved, you seek outside scientific review of these projects. I am glad to serve as the external reviewer of these projects and will provide constructive feedback to their authors. In exchange for my time, you have agreed to assist me with projects of mutual interest in the Colorado River Basin.

I wish you the best of luck with this proposal, which I support enthusiastically.

Yours truly,

Dr. Robert H. Webb
rhwebb@usgs.gov

SKIDMORE
COLLEGE

Dear Paul,

I am writing this letter to express my interest in your *Landscape Imagery* proposal submitted to the National Science Foundation - Distinguished Teacher Scholar program. Over the past several years I have witnessed the Landscape Change Program at UVM develop into a high quality teaching and research tool. I am impressed not only with the scientific outreach to K-12 schools and the success of the program to introduce high-school students to science (and geology in particular), but also with the quality science and the numerous presentations at national meetings. Such a successful program is appealing to me for several reasons.

Skidmore College is located in Saratoga Springs, NY, and our city has one of the fastest growing populations in New York State. Not only is our community experiencing significant development, but the area is rich in history dating back to the Battle of Saratoga during the Revolutionary War (landscape paintings). During the early 1900s Saratoga Springs was the playground of the social elite; thus there are numerous historical photographs of the surrounding landscape just waiting to be documented and re-photographed. I know that a program such as the one you have developed at UVM would benefit Skidmore undergraduates, area high school students, and, in general, the greater Saratoga community.

Skidmore has a close association with Schuylerville Central Schools. I am confident that Schuylerville science teachers, many of whom I know personally, would welcome such a working relationship with Skidmore College and our students. I can see several potential benefits ranging from education and research opportunities for undergraduate and high school students to the dissemination of the findings to the local and scientific communities. In short, I am excited by the potential opportunity to work with UVM and the other potential institutions located throughout the United States to develop a larger network of scientific imagery.

Good luck with the proposal and please contact me when you fully implement the program.

Sincerely,

Kyle K. Nichols
Assistant Professor of Geosciences
Skidmore College

Carleton College
One North College Street
Northfield, Minnesota 55057

Mary E. Savina
McBride Professor of Geology and Environmental Studies
and Humphrey Doermann Professor of Liberal Learning
Perlman Center for Learning and Teaching

507-646-4191
FAX 507-646-4009
msavina@carleton.edu

January 31, 2005

Letter of support for NSF Proposal of Paul Bierman

To whom it may concern:

I am very interested in the application of Paul Bierman's Landscape Change Program to questions of historical archaeology, ecology and geomorphology in Minnesota. I would welcome the opportunity to learn the techniques he and his co-workers are using in Vermont, including the ways to locate images, occupy identical locations for re-photographing, and interpreting the images in terms of landscape change. I am also very interested in the educational materials Paul's group is developing and can share my own experiences building pedagogical web sites as part of the DLESE project "Starting Point" (http://serc.carleton.edu/introgeo/index.html, aimed at teachers of introductory level college geoscience courses). Cathy Manduca of the Science Education Resource Center is another of the P.I.s on the Starting Point project.

In past work in Minnesota and in northern Greece, co-workers and I have used written descriptions of landscapes (for instance, from early surveyors in Minnesota and travelers in Greece) to reconstruct some aspects of landscape change. A photo archive developed intentionally for landscape change studies provides different kinds of evidence, more site-specific and focused on geomorphology. At Carleton, such an archive of Minnesota images will be useful to students and faculty working in Environmental and Technology Studies, Geology, American Studies, and Archaeology.

Sincerely,

Mary Savina

Mary Savina
McBride Professor of Geology and Environmental Studies
Humphrey Doermann Professor of Liberal Learning
Coordinator, Perlman Center for Learning and Teaching

Dartmouth College • *Department of Geography*
Frank Magilligan
6017 Fairchild Building
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Phone (603) 646-1475
FAX (603) 646-1601

2 February 2005

LETTER OF SUPPORT FOR PAUL BIERMAN

To Whom It May Concern:

I am writing this letter in support of Paul Bierman's NSF Distinguished Teacher proposal. Over the past decade Paul has been compiling an array of historical images that chronicle the vast land use change occurring in New England over the past century. The contemporary "Yankee magazine" presentation of New England is indeed a very recent phenomenon: the sustained land clearing in the 19th Century for agriculture and logging had significantly degraded New England's landscapes. Because of demographic and other socio-cultural shifts in the 20th Century, the New England landscape has evolved considerably to its present re-vegetated condition.

Paul's historical image compilation chronicles this landscape change elegantly, yet elegance does not imply simply nor simplicity. It is extremely arduous work and it is extremely important work. Moreover, it is more than a mere chronicling of what happened when and where. Besides the time-consuming task of unearthing these photographs, Paul's project team has also been especially active in re-photographing the same scene at the same scale, including the use of oblique aerial photography to re-photograph riparian conditions along the major rivers in the Upper Connecticut River basin to document long-term changes in channel pattern relative to the 1927 flood-of-record in New England. As a fluvial geomorphologist, this has been extremely important to me and my research efforts, and I have been an active user of these images. Much of my recent work has been on the long-term recovery of New England hydrology following this land use change that Paul has been documenting. Our research has revealed that significant changes have occurred over the 20th Century throughout New England watersheds and that there has been a detectable hydrologic amelioration coincident with this landscape change. Paul's photographs provide considerable corroboration of our research efforts, and, in fact, I have used his images in a recent presentation at AGU.

Besides the utilization of Paul's efforts in the broader scientific community, there are broader extensions to other disciplines. In particular, as a geographer, I am well aware of the significance of these photos in capturing the cultural landscape as well as the physical landscape. New England exists as much as an imagined landscape as well as a "real" landscape, and cultural geographers depend on these sorts of images to represent the historical development of New England as place and as context. The presence of these images has strong inter-disciplinary appeal, and there are many of us across fields that are delighted that these images exist and are readily available (and documented!).

As I hope you can tell from this letter, I am extremely supportive of Paul's proposal. I can certainly speak for myself in support of it, but I think I can easily speak for the array of other physical and social scientists in New England who are delighted that such efforts are

being supported by NSF. If funded, I look forward to participating in the workshop that Paul is organizing: it would be an important vehicle for organizing research efforts on the social and physical dimensions of landscape change in New England.

If you have any questions, please feel free to contact me.

Sincerely,

Francis (Frank) Magilligan
Professor and Chair, Geography

Department of Geosciences
Oregon State University
104 Wilkinson Hall • Corvallis, Oregon 97331-5506
Tel: (541) 737-1201 • Fax: (541) 737-1200 • www.geo.oregonstate.edu

25 January 2005

Letter of Support for NSF Distinguished Teacher Scholar Program
(**HISTORICAL REPHOTOGRAPHY PROJECT, DR. PAUL BIERMAN, PI**)

I write to enthusiastically support Paul Bierman's proposed project.

One of the most important challenges that researchers in a wide range of disciplines face is understanding change over time. Natural scientists seek to do this to comprehend significant processes and developments that often have direct societal impact, such as the depletion of global fishing stocks or the loss of old-growth forests and related habitats. Social scientists are similarly interested in understanding how changes in the built or natural landscape impact individuals and communities over time, while historical geographers and historians (particularly environmental historians) are particularly concerned with appreciating change as a historical process.

Paul Bierman's proposed project promises to make important contributions to all of these research communities – and no less importantly, he proposes a thoughtful, innovative, and exciting means to disseminate this valuable research method to interested communities from secondary schools to college instructors. The larger effort that Bierman proposes would simultaneously make a significant contribution to the environmental sciences research community by helping to create a national repository of historical landscape photographs that can be used – comparatively with contemporary photographs made of the same scene – to study changes in the land.

For many kinds of environmental and landscape studies, one frustrating limitation is that conventional data sets do not extend far into the past. The baseline is therefore short, and only a narrow window opens on critical long-term processes. Bierman's method – comparative rephotography – makes it possible to transcend this limitation in many instances. The work that Bierman and his colleagues pursued in his NSF-funded *Landscape Change Program* in Vermont was precisely the kind of study that Emily W.B. Russell called for in her pioneering *People and the Land Through Time: Linking Ecology and History* (Yale University Press, 1997, 32-3). It is a model effort that will be productively used by researchers in the natural sciences, social sciences and humanities for decades to come.

Bierman is right in noting that there are no national networks of landscape image archives, and no easy way at present for teachers, college instructors, or researchers to

make ready use of the historical photographs that do exist in the file drawers of historical societies, museums, university archives, and state agencies. A growing number of better-endowed facilities are scanning their photograph collections and putting portions of them on-line, so this is a particularly opportune moment to pursue the kind of program that Bierman envisions: it would signal to these archives the importance of cataloguing and indexing geographic information along with other basic details. Alone, the creation of a network of landscape photograph archives would be a tremendous benefit.

I am equally certain that this project will spark great interest among educators across all levels of the curriculum. Students of all ages are fascinated by well-documented photographs, whether they portray familiar landscapes of home or remote landscapes rich with cultural symbols. At Oregon State I teach history of science courses for our graduate science education majors as well as a research seminar on Reconstructing Historical Landscapes in this department. The science ed majors are excited by comparative rephotography because they recognize their students often get absorbed in trying to determine what's different between two photographs of the same scene, separated over time. Members of my research seminar – which draws advanced graduate students from anthropology, archeology, forestry, marine resources management, geology, geography, and history – have found such photographic archives invaluable for addressing a wide range of scientific, policy, and management questions. Such projects do stimulate interdisciplinary interactions. Analyzing historical with contemporary photographs is no less important as a pedagogical tool for undergraduates. What's limited use of them in undergraduate classrooms until now has largely been their inaccessibility.

If asked to take part in the workshops that Bierman plans, I would gladly and willingly participate. This is a most worthy big-vision project.

Most sincerely,

Ronald E. Doel
Associate Professor [History of Science]

P. Thompson Davis
Professor of Geology and Hydrology
Department of Natural Sciences
Bentley, the Business University
Waltham, MA 02154-4705

Letter of Desire to Collaborate

I would be delighted to collaborate with my colleague Paul R. Bierman at the University of Vermont (UVM) should his NSF DTS proposal be funded to develop, demonstrate, evaluate, and disseminate educational materials and ideas focused on landscape change. I have visited Dr. Bierman's home page (http://www.uvm.edu/perkins/landscape/) where he has archived over 10,000 digital images exhibiting landscape change in Vermont using funds from an earlier NSF grant. In my view, this excellent work should be extended nation-wide as Dr. Bierman proposes in his DTS grant application. I could contribute in this effort by expanding the Vermont landscape digital database into northern New Hampshire and Maine, where I have a long-standing record of published research on the geomorphology and glacial geology of the region (http://www.bentley.edu/academics_research/faculty_research/faculty_database/faculty_detail.cfm?id=2133). In recent years, some of my New England landscape research has been in collaboration with Dr. Bierman and his UVM students.

Although Bentley is a business university, we have strong programs in the Arts and Sciences, and one of the institution's strongest suits is information technology (http://www.bentley.edu/academics_research/departments/cis/). For example, one of my colleagues in Bentley's Information Desgin and Corporate Communications Department, Roland Hubscher, is a co-PI on a multi-institutional NSDL grant (http://www.bentley.edu/news-events/pr_view.cfm?id=1608). My current NSF funded grant for glacial geological research on northern Baffin Island is winding down, with all field work now completed, so I would have time to collaborate on Dr. Bierman's DTS project if funded. During most winters, I teach a weekend Edu-trip on the summit of Mount Washington (http://www.mountwashington.org/education/edutrips/schedule.php), and during the past few springs I have taught a weekend Geology of the White Mountain Notches Workshop, similar to a fall offering by Dr. Woodrow Thompson from the Maine Geological Survey (http://www.mountwashington.org/education/workshops/index.html) for the Mount Washington Observatory, where many of my students have been K-12 school teachers. So, I am confident that a K-12 educator and a librarian/historian from New Hampshire or Maine could be identified to work with me on Dr. Bierman's project. I also hold Adjunct Professor status in the Department of Earth Sciences at the University of New Hampshire in Durham, and may be teaching there during my sabbatical in spring 2006. Likewise, I am in the process of developing a cooperative academic relationship with faculty in the new Center for the Environment at Plymouth State University in Plymouth, New Hampshire. These affiliations would strengthen my contributions to Dr. Bierman's project.

WESTERN
WASHINGTON UNIVERSITY

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Geology Department

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Dr. Paul Bierman
Dept. of Geology, Perkins Hall
University of Vermont
Burlington, VT 05405-0122

Dear Paul,

I want to voice my strong support for your NSF Director's Award proposal to expand your Landscape Change Program across the country. I've seen how well the program has worked in Vermont, and am really excited to start a similar program here in the Northwest. In fact, after visiting your Landscape Change web page and talking with you about it at the Visualizations conference last year, I have been discussing trying to do something similar here with our Geology and Science Education faculty at Western Washington University. Your proposed grant would really help us get it going, without having to reinvent the wheel on it.

As you know, Western Washington University has a strong background in Science Education and community outreach (we are the primary teachers' college in Washington), and recently received a large NSF grant (GK-12 Catalysts for Reform) to upgrade science education and teacher training in northwestern Washington. The program, in which our department is a leader, would greatly benefit from your Landscapes program. In particular, the GK-12 program requires a service-learning component for graduate fellows working with local K-12 schools, and the collection, incorporation, and application of your program into the curriculum at these schools would be an excellent regional project. It would not only enhance student learning and appreciation for the dynamic nature and history of the Northwest, but also link schools in a common project across the region, particularly the often isolated rural and Native-American schools that may have less opportunity to be involved in such broad national initiatives.

I also want to support the underlying justification for your proposal. As a geomorphologist, I regularly use imagery and animations in my classes and research, and have documented the value of high-quality, pedagogically-based visualizations in improving student learning and analytic abilities in science. I have been particularly impressed with the response to your Landscape Change program, both from other professionals (as at the NAGT Visualizations workshop last year) as well as from K-12 educators. When I showed your Landscape web page to several teachers and education graduate students at WWU last year, they were really excited about the potential to develop a similar program here. The main difficulty they saw was the time and effort needed to develop the infrastructure to get such a program underway. If funded, your project would go a long way to solving this concern.

I'd be extremely interested in collaborating with you to help bring your landscape change program to the national level. I encourage any reviewers to consider the scope and potential impacts of your proposal when evaluating it. This is perhaps one of the most interesting and useful science-education projects I have heard of, and I sincerely hope it is funded.

Please let me know if I can help in any other way.

Best regards,

Douglas H. Clark
Assoc. Professor
Geology Department

LETTER OF COMMITMENT AND SUBCONTRACT AGREEMENT

CATHRYN MANDUCA OF SCIENCE EDUCATION RESOURCE CENTER, CARLETON COLLEGE

Carleton College
One North College Street
Northfield, Minnesota 55057

Cathryn A. Manduca, Director
Science Education Resource Center
serc.carleton.edu

507-646-7096
FAX 507-646-5175
cmanduca@carleton.edu

Paul Bierman
University of Vermont
February 3, 2005

Dear Paul:

Thank you for including the Science Education Research Center (SERC) of Carleton College in your *Distinguished Teacher Scholar* proposal. I enthusiastically support your effort to expand the use of landscape images in teaching science. Having recently done an external evaluation of your NSF-funded *Landscape Change Program*, I am very familiar with the work you and your colleagues are doing at the University of Vermont and look forward to working with you again. I am particularly pleased that you recognize the important role that understanding the use and impact of the website plays in further development of the program as well as recognizing the importance of external evaluation to the quality of your development and dissemination efforts.

The proposed work builds in important ways on the previous evaluation. Our collaboration on evaluation of the impact of visually-oriented learning modules and their use as part of both face to face and on-line courses is of high interest to me and the rest of us at SERC. The outcomes of the national workshop "Teaching with Visualizations in the Geosciences" < http://serc.carleton.edu/NAGTWorkshops/visualize04/> that I hosted at Carleton last year reinforced that learning from images is both an integral part of the geosciences and something we don't understand very well. This project offers an exciting opportunity for us to work together doing educational research in this area.

The *Science Education Resource Center* is pleased to participate in your project. We will focus our work with you in two areas: website evaluation and evaluation of the image-based portions of both your on-line and face-to-face course. We will also provide you with established instruments so that you can evaluate the effectiveness of the workshops you will run.

To evaluate the website we will:

- Develop an evaluation plan that includes both formative evaluation of the website design and its usability and summative evaluation of the use and impact of the website on your target user population.
- Train you to implement the formative evaluation.
- Execute the summative evaluation which will involve analysis of website usage, an on-line survey, and phone interviews or focus groups.
- Develop a report summarizing the website evaluation.

To evaluate the impact of visually oriented modules in both your on-line and face to face course we will:

- Collaborate in the development of a research and evaluation plan to determine the role that image modules are playing in your courses and their impact on student learning.
- Collaborate with you to implement this research and evaluation plan.
- Report our results in a jointly authored paper for publication.

We understand that you will include the attached budget in your proposal and that if successful this will be administered as a subcontract to Carleton College. The subcontract will fund the participation of:

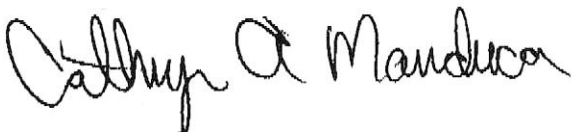
Cathryn Manduca, *SERC Director*, will be responsible for overseeing the project work at SERC and will take part in the design of evaluation plans and analysis of data. (2 weeks in years 1 and 3)

Ellen Iverson, *Evaluation Specialist*, will be responsible for development of the website evaluation plans, training for formative evaluation, execution of the summative website evaluation, and development of the website report. She will also participate in the study of the course materials. (1 month in years 1 and 3).

We understand that funds for travel necessary to complete this work are contained in your project budget.

Best wishes for a successful proposal.

Sincerely,



Cathryn A. Manduca
Director

Bierman - Distinguished Teaching Scholar Carleton Sub Contract Budget

Budget

	2005-2006	2006-2007	2007-2008	TOTAL	
Iverson salary (1 month per year)	$ 4,456.83	$ -	$ 4,635.11	$ 9,091.94	
Manduca salary (2 weeks per year)	$ 4,310.71	$ -	$ 4,483.14	$ 8,793.85	
Total Salaries	*$ 8,767.54*	$ -	*$ 9,118.24*	$ 17,885.79	*$ 17,885.79*
benefits (35% of wages)	$ 3,068.64	$ -	$ 3,191.39	$ 6,260.02	
office expenses/phone	$ 100.00	$ -	$ 100.00	$ 200.00	
Total Direct	*$ 11,936.18*	$ -	*$ 12,409.63*	$ 24,345.81	*$ 24,345.81*
Indirect	$ 3,331.67	$ -	$ 3,464.93	$ 6,796.60	
TOTAL	**$ 15,267.85**	$ -	**$ 15,874.56**	$ 31,142.41	**$ 31,142.41**