New Hampshire Space Grant Consortium
2009 Annual Performance Data
University of New Hampshire (UNH)

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PROGRAM DESCRIPTION

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowship and scholarship programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The **NH** Consortium is a Designated Consortium funded at a level of **$785,000** for fiscal year 2009.

PROGRAM GOALS

The strategic goal of the NHSGC is: *To stimulate and enhance awareness and understanding of our nation's continuing quest into Space by providing 1) Support to New Hampshire's college and university students in Space-related fields; 2) Space-related educational materials, programs, and resources to the State's educators; and, 3) Greater access to Space-related information and technology for the benefit of the State, its businesses, and citizens.*

The NHSGC will pursue this goal across a broad front of programs, with particular emphasis in the following areas:

1- Providing fellowships, scholarships, and internships to the State's graduate and undergraduate (including community college) students pursuing studies in NASA-relevant science, engineering, and technology. At all levels, support is connected strongly to mentored research experiences for students. Awards will address the established need for a larger, more diverse U.S. technical workforce.

2- Providing resources, information, and training to the State and region's educators in science, math, and technology. At the K-12 level specific emphasis is placed on

teacher/student activities incorporating realistic, “hands-on” experience, in support of State and national guidelines for science, math, and technology curricula.

3- Creating increased access to NASA-relevant science and technology through informal educational institutions and other programs oriented towards the general public. The intrinsic appeal of Space exploration is utilized as a means to attract larger and more diverse audiences. Access to NASA-relevant geospatial technologies and their applications will be enhanced.

PROGRAM/PROJECT BENEFIT TO OUTCOME (1,2, OR 3) PROGRAM ACCOMPLISHMENTS

Outcome I: Contribute to the development of the STEM workforce in disciplines related to NASA’s strategic goals:

- 58 awards were made to state college/university students including scholarships, fellowships, internships and higher education research opportunities for students. Of these awardees, 53% were female and 7% were under-represented (excluding Asian) minorities.
- 41 additional undergraduate STEM-course and e-course scholarships supported college and high school students taking college course on the six community college campuses. 66% were female and 3% were under-represented (excluding Asian) minorities.
- Three scholarships through the collaboration of University of New Hampshire (UNH), and Elizabeth City State University (ECSU), supported STEM students at ECSU who also visited UNH and participated in the UNH undergraduate research program. ECSU is a minority-serving institution (HBCU) in North Carolina.
- A new course on Satellite Systems and Instrumentation was featured at UNH in the spring of 2009 through collaboration between the Physics Department, Mechanical Engineering, the Institute for the Study of Earth, Oceans, and Space, NH Space Grant industrial affiliate BAE Systems, Inc. and NH Space Grant. The course covered mission types, mission design and planning, the orbital and launch environment, instrumentation, spacecraft dynamics, electrical systems, mechanical systems, thermal control, testing and applications. BAE engineers and managers interacted with the students during the course, as professionals involved in satellite systems as well as making the students aware of internships and other opportunities at BAE Systems.
- UNH’s Cooperative Extension project to promote awareness of, access to, and use of remotely sensed image data products for the State of New Hampshire exceeded its goal of cataloguing 50+ image data sets by processing in excess of 300 TM image data sets over FY2009. Their prototype website allows a user to query and discover available imagery based on a user-defined point, line or polygon.
- UNH’s Institute for the Study of Earth, Oceans and Space substantially increased the ESS satellite image and geo-spatial data archive used in research, education and outreach by 4.5TB bringing their total data holdings up to approximately 20 TB.
- Three mechanical engineering and computer science students at UNH received awards to support their undergraduate research and participation in the Undergraduate Research Opportunity Program. Two of these students went on to summer design

internships leveraging ESMD support to expand their research experience.

- Support for a UNH Physics and Math award recognized undergraduate research excellence in the Undergraduate Research Conference's Interdisciplinary Science and Engineering Symposium.
- The two graduate students supported by Space Grant scholarships at Plymouth State University graduated. One has gone on to graduate school, while the other is working at the National Climate Center. The four other undergraduates and one masters student supported by Space Grant scholarships and a fellowship at PSU are continuing with the program and are academically successful.
- The Women in Science Project at Dartmouth provided 12 female undergraduate students with opportunities to conduct scientific research through collaboration with senior researchers and present their research at the annual Watterhahn Science Symposium. These internships are a cornerstone opportunity provided by this program that seeks to attract and retain women in STEM fields.
- An Astrobiology graduate student was selected by the WISP program to attend an advanced six week course on evolutionary biology "Embryology Concepts and Techniques in Modern Developmental Biology". The student reports that this was a significant experience in her education.
- Dartmouth's WISP Program expanded its focus to include advancing the careers of women graduate students and post docs in the sciences and engineering. There were two themes around which competency-building programs were developed: skills development workshops and faculty facilitating professional connections. 374 graduate, postdoc and undergraduate students attended nine skill development workshops offered on topics including "A Pipeline of Women in Science – With a NASA perspective", "WISE Dinner with Astrobiologist Nicole King", "Wise Visit with environmental Polar Scientist Stephanie Pfirman" and a WISE Lunch Seminar Series with Dartmouth Women Faculty". Students reported;

> "As graduate students we have no idea about what … we should expect when a job offer is made. The presentation was very thorough and now I have a much better feel on how to handle question, what can be negotiable, and so much more."
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> "As a young woman who is embarking next week on her first tenure-track faculty campus interview, it was really helpful to hear from Stephanie some data about typical workplace and hiring biases that I may encounter during my interview (and any subsequent application and interview processes). We often don't have the time to become informed about these things since we are working so hard to perform well in science!"
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> "I hadn't thought a lot about graduate school or my plans after that, but now I will. The presenter introduced so many opportunities and resources for ways that we could connect with NASA."
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> "It was inspiring for me to hear first hand that a woman can be a successful scientist and mother, and that even though grad school is so difficult right now it does get better. It's comforting to know that women do go through these challenges and come out just fine on the other end!"

- The Director of Dartmouth's WISP Enhanced program was selected to be one of NASA's educator guests at the viewing of the launch of Space Shuttle Discover, STS

131. She was also invited to be a panelist in the Women Engineering and Robotics Pre-launch Education Forum organized by NASA's Office of Education. Thirty educators from across the country attended the panel on "Higher Education Exploring Gender Issues and Women's Participation in Sciences" and asked questions about promising practices for recruitment and retention, the value of support networks, work-life balance and high school outreach.

- Dartmouth's Visiting Young Scientist award retained another PhD scientist in a space-related academic field by providing an opportunity for them to pursue externally funded research and teach a course to motivated undergraduate and graduate students. Teaching experience is one thing many recent graduates lack, and this program gives them the experience which subsequently places the VYS in an academic position at an Institution of Higher Education. The FY09 VYS taught a course in Applied Remote Sensing and Arctic Hydrology. He has gone on to an academic position at the University of Massachusetts at Amherst. This highly successful program has also resulted in several scholars becoming well known in their fields. For example, Mike Wiltberger, an early visiting fellow, is now an active space physics researcher based at NCAR, and Roby Millan, is now an assistant professor at Dartmouth and PI of a high-profile NASA balloon program.
- Dartmouth's six undergraduate internships were highly successful because the students had successful research experiences in fields important to the NASA SG goals and several produced manuscripts for peer-review, and/or presentations at conferences.
- Three Space Grant awards are made to select graduate students in space science or remote sensing fields, from among candidates nominated by faculty members. One award went to a PhD student and the other two to masters degree candidates. The award has become quite competitive with many well-qualified nominees.
- Dartmouth College offered 30 Plasma Physics seminars in FY 2009 with an average attendance of 30 individuals, typically half graduate students, one-quarter faculty and one-quarter research staff or others. Attendance has increased as Dartmouth's program in space physics has grown. There are five faculty members organizing these weekly events, which bring together this scientific community on campus. The seminars play a critical role in educating students, initiating new collaborations and enhancing existing ones, and disseminating the newest knowledge in the field.
- Two Dartmouth students used their research support to design, build, and test a switching circuit capable of driving radar transmitters. This work supports a pair of radars in Oregon, augmenting the existing SuperDARN network, which is making measurements of the plasma convection in the Western portion of the hemisphere.
- The Watterhahn Symposium at Dartmouth featured 15 undergraduate students presenting their research related to space, aerospace engineering or remote sensing. The keynote speaker was planetary scientist Fran Bagenal from the University Colorado who gave a speech on Jupiter and shared NASA science and NASA missions, such as the upcoming Juno mission. Nearly 200 attended the keynote, with 300 participants in the symposium.
- A Dartmouth undergraduate student in Earth Science obtained a summer job working on the Greenland ice cap. With space grant support he built a specialized antenna and receiver for measuring low frequency radio beacons and deployed it while on the ice

cap.

- CCSNH's campaign to communicate information about NASA's mission and Space Grant Scholarship program resulted in a substantial increase to 46 in applications as well as an increase in scholarships awarded to 32; well over the goal of 25.
- The recently developed e-Start initiative, for high school juniors and seniors to take college level courses on-line and earn college credits, continued with a successful offering of the new Biology 1 course. Previously, there had been a shortage of enrollees, but the student scholarships and other Space Grant support for this course resulted in more then enough enrollment for a successful offering.
- Phenology data collection by one graduate and two undergraduate students on the Mount Tecumseh transect continued through a partnership between the Rey Center and Plymouth State University's Center for the Environment.
- The Astronomy Internship at the McAuliffe-Shepard Discovery Center engaged an undergraduate student majoring in astronomy and physics for ten weeks. He created field trip activity guides for use by educators; developed content for the Astronomy Bowl on dark matter and energy and the IBEX mission; and led public presentations using a portable digital planetarium. After completing the internship, he was selected for a 10-week internship at Arecibo Observatory in Puerto Rico, working on finding galaxies surrounding the known, and thought to be isolated, galaxy UGC 2082.

  He writes: "Hopefully I will find some galaxies that were previously unknown, I have already found over 50 potentials By looking through other survey data from optical bands, I am currently trying to compare the radio sources I have found to galaxies visible with a optical telescope. I might even get to use the telescope to re-observe some of the sources later on in the summer! The 305-meter spherical dish at Arecibo is the largest single-aperture radio telescope in the world, I recently got tot take a cable car up tot the focus of the dish, over 400 feet suspended in the air, the views were spectacular."

Outcome 2: Attract and retrain students in STEM disciplines through a progression of opportunities for students, teachers and faculty:

- FIRST/UNH initiated the development of an Earth Systems Science workshop and curriculum for middle school teachers with plans for it to become a pre-service teacher course. Two faculty from the University of New Hampshire have designed two, two-day workshops for upper elementary school and middle school science teachers integrating the innovative First Lego League robotics experience with NASA-based earth systems science content. UNH faculty met with Gilford Middle School and North Country Educational Services in Gorham several times to discuss and schedule the workshops for 2010-11. This program has been augmented with a donation by FIRST of FLL field set-up kits and materials to support these rural NH classrooms.
- The Mount Washington Observatory's Educational Outreach program reached 4,789 students through their climate and weather education programs, including distance-learning classes by meteorologists living and working atop Mount Washington.
- Rey Center staff conducted 39 K-8 science programs, with 31 students from three classrooms for a total of 605 contact hours.
- 32 Forest Watch classrooms submitted spectral and biometric data in 2009 involving 20 high school, 7 middle school and 4 upper elementary classrooms. Each school

established a 30 meter square plot (PSSP) and collected tree and stand level biometric measurements, as well as foliage for performing spectral analysis and needle analyses. Collected data was then compared to tropospheric ozone data obtained from the state and Environmental Protection Agency. The small differences seen between UNH researchers', other sources and Forest Watch students' is a sign that Forest Watch continues to produce accurate and valuable data. Each year the database increases and student understanding of white pine growth habits and health status improves.

- The Project SMART summer institute for talented high school students in science and mathematics engaged its most diverse group of participants in the summer of 2009. Through contacts with the University of Alaska and their summer program called RAHI (Rural Alaska Honors Institute) three students from rural Alaska spent a month as researchers in NH along with minorities from urban and rural areas of New England. There were 52 applicants and 43 attendees; 9 in Space Science, 10 in Marine and Environmental Science and 24 in Biotechnology and Nanotechnology. 63% were male and 37% female. In addition, nine graduate students (4 females and 5 males) and 7 undergraduate students (6 females and 1 male) gained research and teaching experience. As one student commented: "I really appreciate the chance you gave me to participate in Project SMART. The Space Science program was outstanding. I learned many things about the field of Space Science and I think that now I am even more interested in it." Another student remarked: "It opened my eyes to fields of research I may pursue."

Outcome 3: Build strategic partnerships and linkages between STEM formal and informal providers that promote STEM literacy and awareness of NASA's mission:

- Funding was provided to create an interactive exhibit at the McAuliffe Shepard Discover Center on what life is like for astronauts living and working in space; to relate what astronauts use to accomplish their space tasks; and to understand conditions in space. Over 30,000 people had the opportunity to interact with the exhibit. Visitor interest in/engagement with NASA, the Sky Lab, and Shuttle artifacts significantly increased after including education and graphic panels. The number of visitors to their related pre-existing exhibits and the time spent at each increased substantially.
- Monitoring and maintenance of the automated weather station on top of Mount Tecumseh, NH, with the associated live feed on the web, has continued with the collaboration of the Rey Center and Plymouth State University (PSU) Meteorology program. The station is a centerpiece of the Rey Center's community research and public outreach programs.
- The Water Watchers volunteer water quality monitoring program on Mad River and Snow's Brook provided data from twelve sessions, May to October of 2009. This data was submitted to the NH DES Volunteer River Assessment Program.
- The Rey Center conducted nine Curious Kids programs, seven SEEDS Club programs and six Tecumseh Overnight trips involving 235 young people in science exploration and learning.
- Summer Stewards atop Welch mountain during July and August interacted with approximately 900 visitors about the peak's weather and climate, geology and visitor impact on the fragile environment.
- Six Astronomy nights were jointly offered by the McAuliffe-Shepard Discovery Center

and Rey Center in Waterville Valley attracting 89 participants.

- Two staff at the McAuliffe Shepard Discover Center participated in professional development opportunities, including the annual meeting of the Astronomical Society and Association and Science-Technology Centers conference, in order to ensure current knowledge and best practices are incorporated into the Center's STEM programming.
- "Across the spectrum" an exhibit on the electromagnetic spectrum was made more useable to blind and visually handicapped people with auditory guides.
- 573 people, from toddlers to grandparents, participated in a one-day festival that included NASA, STEREO, AESP and NH Space Grant booths, activities by NHSCG affiliates, weather balloon launches, model rocket launches, robotics, a new planetarium show, telescope displays including solar viewing with NH Astronomical Society, aviation exhibits, helicopter rides, shuttle and lunar lander simulators, Mars exploration booth, space suite and tools booth, NASA moon rocks, microgravity demos, and a keynote speech by NHSCG board member and PSA meteorology Department Chair James Koermer.
- Support was provided for statewide GIS educational activities through UNH and the Cooperative Extension system.

PROGRAM CONTRIBUTIONS TO PART MEASURES

- **Longitudinal Tracking**:

Student Data and Longitudinal Tracking: Total awards = 99; Significant Fellowship/Scholarship 83; Higher Education/Research Infrastructure = 16; 4.7% of the total award represent underrepresented minority F/S funding.

During the FY09 program year, one graduated and is pursuing an advanced STEM degree, 7 accepted STEM positions in industry, 2 accepted STEM positions in academia, and 19 went on to non-STEM fields or their next step is unknown at this time.

For all students that were significantly supported in the period spanning FY06-FY09, 12 graduated and are pursuing advanced STEM degrees, 3 accepted STEM positions at NASA contractors, 12 accepted STEM positions in industry, 2 accepted STEM positions in K-12 academia, 6 accepted STEM positions in academia, and 18 went onto non-STEM fields or their next step is unknown at this time. The remaining students have not yet received the degree that they were pursuing when they received their Space Grant award.

FY09 NHSGC Graduate students supported:

- PSU's two 2009 graduate students completed their thesis research, with NHSC support at KSC/CCAFS, during the 2009-2010 academic year and graduated in May. One is heading to the PhD program in Atmospheric Science at the University of Utah and the other has started work at the National Climate Data Center in Asheville.
- Two of Dartmouth's 2009 Earth Sciences space grant fellows are still pursuing further education and the one graduate is working in industry as a geoscientist.
- Two of UNH's 2009 space grant fellows continue with their masters, one has gone on

to a PhD program, one is working in the EOS Climate Change Research Center, and one is working as a researcher/engineer at the Woods Hole Oceanographic Institution.

- **Course Development**:

One new graduate-level course on Satellite Systems and Instrumentation was featured at UNH.
One new course was offered at the Great Bay Campus of the Community College System of New Hampshire targeted at high school students seeking to get college credit to jumpstart their STEM higher education.

- **Matching Funds**:

The $915,391 in matching funds is well above the requirement for matching non-fellowship NASA funding.

- **Minority-Serving Institutions**:

NHSGC maintained its initiative with Elizabeth City State University, and historically black university (HBCU) in North Caroline, awarding 3 scholarships to undergraduates in STEM disciplines related to NASA's workforce, with 4 students from this minority serving institution participating in UNH's Undergraduate Research Opportunity Program.

IMPROVEMENTS MADE IN THE PAST YEAR

Statewide awardees of the CCSNH NASA Space Grant/PSNH Scholarships continue to increase over the previous FY, with more colleges in the System participating through their continuation of enhanced promotion.

Additional collaboration between NHSG and FIRST Place was fostered by the consortium's new Educational Program Coordinator's previous employment at FIRST. For example, donations of kits and materials supplemented the UNH FLL Earth Systems Science project; remote programming at a Community College site is developing for *FIRST*'s Women in Science and Technology program; an internship at FIRST was filled by a UNH engineering student; and a FIRST volunteer was nominated as part of a NH team to attend NASA's Robotics and Education Forum.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

The NHSGC has nine members. The lead institution is the University of New Hampshire, including UNH Cooperative Extension, with associate Dartmouth College, and affiliates FIRST Place, the Community College System of New Hampshire, the McAuliffe-Shepard Discovery Center, Plymouth State University, the Mount Washington Observatory (added in 2006), the Rey Center (added in 2007), and BAE Systems of North America (added in 2007).

The University of New Hampshire (UNH), located in Durham, NH, is the state's flagship research university, enrolling 11,600 undergraduates and 2400 graduate students. Research and PhD programs relevant to aerospace are offered in physics, engineering, math, computer science, and a cross-college program in natural resources and Earth system science.

A part of UNH is Cooperative Extension which provides NH citizens with research-based education and information, enhancing their ability to make informed decisions that strengthen communities, sustains natural resources, and improves the economy. Space Grant collaborations are in the areas of geospatial technology and applications, resource management, and workforce development.

Dartmouth College, located in Hanover, NH, is a private liberal arts college (ninth oldest in the nation) and a member of the Ivy League. The college has 4,100 undergraduate students, 1,600 graduate students, and 600 tenure/tenure-track faculty. Aerospace-related undergraduate and doctoral degree programs are offered in physics and astronomy, engineering, computer science, and Earth science. Extensive research is conducted in solar-terrestrial physics, astronomy, satellite remote sensing, robotics, and computer science applications.

The Community College System of New Hampshire (CCSNH, formerly the New Hampshire Community Technical College System) is New Hampshire's statewide system of two-year colleges, offering associate degrees, professional training, and transfer pathways to four-year degrees. CCSNH is comprised of seven colleges within the state: Great Bay Community College in Stratham; Lakes Region Community College in Laconia; Manchester Community College in Manchester; NHTI-Concord's Community College in Concord; Nashua Community College in Nashua; River Valley Community College in Claremont and Keene; White Mountains Community College with locations in Berlin, Conway, Littleton, and Woodsville. CCSNH is the primary provider of skilled workers and technicians in the State. Space Grant supports a NASA scholarship program for STEM students, linked to the private sector and also supports STEM curriculum development within the college system.

Plymouth State University (PSU), located in Plymouth, NH, is part of the University System of New Hampshire and has a current student enrollment of about 4200 undergraduates and 2600 graduate students. Space Grant funding provides research-oriented scholarships and fellowships in the meteorology program, with an emphasis on providing support to women undergraduate students.

FIRST Place is an innovative R&D facility in Manchester, NH, linked to Dean Kamen's nationwide FIRST robotics programs. It provides students, teachers, and the general public an encouraging environment for exploring concepts of science and technology. FIRST Place collaborates with UNH in curriculum development for pre-college science teachers. UNH and BAE Systems provide mentors and support for NH school teams involved in FIRST competitions.

The Mount Washington Observatory (MWO), in the White Mountains of NH, is a non-profit organization providing environmental observation and education while supporting scientific research. Current research projects address summit weather and climate, regional air quality, and global tropospheric chemistry. MWO, UNH, and PSU work together on many Space Grant activities, including internships and research projects.

The mission of the McAuliffe-Shephard Discovery Center (MSDC), located in Concord, NH, is *to educate, incite, and entertain learners of all ages in the sciences and humanities by actively engaging them in the exploration of astronomy, aviation, and Earth and space science*. As many as 60,000 school children and other visitors explore the Planetarium annually. The Planetarium is NASA's Educator Resource Center for NH. Space Grant supports the development of Planetarium shows and exhibits, teacher workshops, and space science fairs; often in collaboration with other NHSGC affiliates.

The Margret and H.A. Rey Center, in the Waterville Valley, honors the legacy of Margret and Hans Rey, authors of Curious George books and *The Stars, a New Way to See Them*, among other works. The Rey Center provides initiatives in environmental stewardship and informal educational programs in the astronomy and local ecological systems. NHSGC resources are used by the Rey Center to initiate several citizen science community outreach programs and cooperative research initiatives. Among these are the Tecumseh Overnights Program, Tecumseh Vegetation Phenology Research Transect, the Lorenz Weather Station, and the Water Watchers water quality-monitoring program.

BAE Systems is part of an international company that develops and supports advanced defense and aerospace systems, and is headquartered in Nashua, NH. As our first industrial partner, BAE Systems provides internship opportunities for undergraduate and graduate students from our consortium's academic institutions. BAE Systems also supports and mentors teams for FIRST Robotics, FIRST Tech Challenges, and FIRST Lego League.