FY 2019 Year 5 Extension Annual Performance Document

New Hampshire Space Grant Consortium Lead Institution:
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Lines of Business (LOBs): NASA Internships, Fellowships, and Scholarships; STEM Engagement; Institutional Engagement; Educator Professional Development

A. 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 fellowships and scholarships 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 New Hampshire Space Grant Consortium is a Designated Consortium funded at a level of $760,000 for fiscal year 2019.

B. PROGRAM GOALS:

The New Hampshire Space Grant Consortium strategic goal is to contribute to the education and development of an inspired, highly skilled, technically literate, diverse workforce in NH that provides potential human resources and research expertise to support NASA strategic goals. The Consortium consists of a statewide network of affiliates that provide a variety of education, research, and informal education programs and activities that contribute to achieving this goal. Consortium objectives for the fifth year include the expansion of opportunities for students within the State to participate in, and make connections with, NASA aeronautics and space programs; and developing science, technology, engineering and mathematics (STEM) education opportunities in New Hampshire, including pre-college and informal education pipeline activities — being mindful of benefits to the State, its businesses, and its citizens.

The 5th-year programs emphasize the following State-level objectives: 1) Providing fellowships, scholarships, and experiential opportunities to graduate, undergraduate and associate degree students pursuing studies in NASA-relevant STEM fields at NHSGC affiliates of higher learning. 2) Fostering STEM student diversity in New Hampshire. 3) Providing additional professional development for the state and region's STEM educators. 4) Supporting additional informal science education activities designed to inspire future scientists and engineers (pipeline activities) and to increase public access to NASA science and technology. 5) Enhancing university research infrastructure.

SMART Targets for Primary Elements

1) Match or exceed New Hampshire's non-Asian/non-Pacific Islander minority higher education enrollment in ethnic diversity (19.8%) in the combined primary elements, consortium-wide
2) Match or exceed 40% female awardees in the combined primary elements, consortium-wide
3) Provide at least 43 NIFS awards, consortium-wide
4) Support at least 6 higher education students in research assistantships and provide travel support to 20 students
5) Support at least 1 student symposium and 1 seminar series annually, showcasing NASA-related research
6) Where and when required, provide longitudinal tracking of significant awards using the EPSS Tracking System. Submit student information as required into the OEPM system
7) Support curriculum or faculty development for 6 STEM faculty, which may include early-career post-doctorates
8) Support enhancement of a data analysis research tool for expanding the NH LiDAR resources by developing a Canopy Height Model data layer and slope data layer for the whole of NH.
9) Support infrastructure (software development) for surface-installed magnetometers engaging university researchers with high school student activities

SMART Targets for Secondary Elements

10) Provide 220 precollege (K-12) in-school, after-school, and distance learning programs reaching at least 1000+ students
11) Provide at least 3 STEM K-12 events on a college campus
12) Support an annual 1-day aerospace festival for the general public, engaging 300 persons
13) Support a Planetarium Show
14) Support an Apollo XI moon landing exhibit
15) Support 3 informal educator(s) in professional development activities
16) Support a public series of STEM programs involving high school and community college students to create planetarium show components.

C. PROGRAM/PROJECT BENEFITS TO PROGRAM AREAS:

NIFS Benefit, an undergraduate: 'The experience I gained as an undergraduate doing research under the NH Space Grant allowed me to get a research position upon graduation, which in turn secured me a position in one of the top Earth Science/Oceanography PhD programs in the world. I do not think my career trajectory would have been possible without those early research experiences. Starting a year after graduating with a Bachelor's degree, I worked for 4.5 years developing algorithms and procedures to derive bathymetry, water quality, and habitat health characteristics from remotely sensed data. These efforts extended our abilities to use satellite data and justified further development of earth observing platforms.' (James Bramante, 2008& 2009 Undergraduate Scholarship - Dartmouth College)

NIFS and PC Benefit, a community college student: 'My life has been deeply changed by this

experience. I continue to provide volunteer programming in stem for ages four through 18 all over my county in many capacities and at many sites with many organizations. The program I founded, and continue to develop through my volunteer work, called Be GIFTS (Boys and Girls Initiating Future Thinking In Science) has had excellent preliminary results with aerospace components that I have provided in my programming. I have been in communication with a local children's museum which is developing an aerospace exhibit floor this summer and they have used many of my ideas and feedback to help begin the process of developing this exhibit. I have guided them to resources such as the NASA space consortium and NASA kids resources.' (Colleen Ross, 2015 & 2017 Space Grant Undergraduate Scholarship - River Valley Community College)

D. PROGRAM ACCOMPLISHMENTS:

Primary elements

NASA Internships, Fellowships, and Scholarships (NIFS): . SMART metric 3 (Target exceeded). 75 NIFS awardees were funded. UNH supported 14 students (fellowships and NASA internships); PSU supported 16 students (fellowship/scholarships); 38 Community College students scholarships; and Dartmouth awarded 7 students (fellowships).

Represented STEM disciplines in NIFS awards included aviation technology, advanced machine tool technology, mathematics, computer science, cyber security investigations, life science, biology, bioengineering, mechanical engineering, electrical engineering, chemical engineering, civil engineering, engineering physics, space science, physics, earth science, geospatial science, environmental science, meteorology, and STEM teacher (K-12) certification.

Higher Education Projects: These include individual student research experiences and team research experiences; seminar and symposium support; and student travel support.

HE SMART Metric 4, Supporting Student Research (Target exceeded): 27 higher education students received direct funding, including 9 UNH students, 16 Dartmouth students, and 2 students working at MSDC.

The Women in Science Project (WISP) at Dartmouth College provides internships to first and second-year women students doing research in areas related to NASA. WISP has been shown to have a positive effect on retention of women in STEM disciplines, and it thereby makes significant contributions to Space Grant diversity goals.

At UNH, three undergraduate Physics students were funded for a 10-week intensive summer research project through REAP (Research Experience and Apprenticeship Program). Research assistantships provide support allowing individual students to actively participate in specific STEM research projects. Three undergraduate students in Mechanical Engineering also received funding as counsellors for the annual UNH Tech Camp, where they supervised and assisted middle- and high-school students in STEM concepts and projects.

HE SMART Metric 4, Supporting Student Research and Conference Travel (Target not met): 13 students received travel support. Dartmouth supported travel for 11 students attending and presenting at conferences at the AGU meeting in Washington, DC, Lunar and Planetary

Science conference in Houston, TX and the CEDAR (Coupling, Energetics and Dynamics of Atmospheric Regions) Workshop in Santa Fe, NM. PSU funded one student's travel to two meteorology conferences: the 99th Annual Meeting of the American Meteorological Society in January 2019 in Phoenix, AZ and the Northeastern Storm Conference in March 2019 in Saratoga Springs, NY. UNH funded registration for one student students to conferences.

HE SMART Metric 5, Symposia and Seminar Series Support (Target met): Space Grant provided support to the Undergraduate Research Conference (student symposium) held each April at the UNH-Durham campus, and the 27th annual Karen E. Wetterhahn Science Symposium at Dartmouth College. During these symposia, students presented posters highlighting their research. Support was provided to the space plasma seminar series at Dartmouth College, which is co-sponsored by the Departments of Physics and Astronomy and by the Thayer School of Engineering. These seminars are a long-running series of weekly talks focused on plasma science and space physics. Space grant supported travel for seminar speakers.

NIFS/HE SMART Metric 6, Longitudinal Tracking (Target will be met): Student data will be provided to the tracking service provider prior to the OEPM deadline.

Research Infrastructure Projects (RIF): These include higher-education faculty professional development, early career development, and research infrastructure.

RIF SMART Metric 7, Faculty Development (Target partially met: 5 of 6): Five PSU meteorology faculty members received support to attend and participate in the annual American Meteorological Society convention held in January 2019. Dartmouth College was not able to find a viable candidate matching the reporting cycle for the Young Visiting Scientist position, but is continuing its efforts during the award cycle.

RIF SMART Metric 8, Data Analysis Tool (Target met): The first significant activity required to accomplish the project objectives was the development of a statewide bare earth digital elevation model (DEM), which was generated by mosaicking and standardizing data from the 9 available LiDAR collections. We produced a statewide .las dataset and generated the LiDAR-based first return elevations. We are currently generating the CHM, subtracting the bare earth elevation from the first return elevation. The slope layers have also been generated from the statewide bare earth DEM. Final processing and documentation are now underway in preparation for submitting these key datasets to the NH GRANIT Clearinghouse site for widespread distribution. We have completed the urban, wetland, and forest classes with satisfactory results for a tri-town area in central NH. The cleared and agricultural classes, particularly golf courses, proved more difficult to differentiate, and were processed separately to accommodate testing alternative approaches and image band combinations. The processing is now complete, with all procedures documented and available to be applied in the future. We are hopeful that the product of our efforts will serve as a proof of concept to secure funding for the production of a statewide data set.

RIF SMART Metric 9, Cross-level Magnetometer Program (Target met): This program brings near-Earth space science into high school classrooms. Five Fluxgate magnetometers have been completed, and three of them are taking data. Data from these magnetometers reach science quality and can be used for science investigations. More magnetometers will be built, as well as a network and data collection in the Data Discovery Center (DDC) at

UNH, which will make these data publicly available for researchers and schools. The software interface which was proposed has been completed. Data can be reliably transmitted from the MAG to the DDC, and students and researchers are able to display and analyze measurements and include these data into the DDC. Minor adjustments are still needed for field deployments.

Secondary Elements: *Pre College Projects*. STEM programs for K-12 students, both in and outside of the classroom (e.g., STEM camps), and K-12 teacher professional development (e.g., workshops).

PC SMART Metric 10, Precollege Learning Programs (Target exceeded): 232 programs were conducted reaching more than 1550 K-12 school students (exceeding the expected number of 1000). Activities included in-class instruction (MWO) and out-of-classroom STEM Camps, Tech Days, and Career Days (UNH, Community College, MSDC).

PC SMART Metric 10, K-12 Teacher Professional Development (Target exceeded): MWO and MSDC outreach programs and provided experiential research activities for 22 K-12 teachers. MWO's *Arctic Wednesdays* professional development program introduces local elementary, middle and HS teachers to the unique arctic laboratory that is Mt. Washington in winter. Teachers spend a day at the Observatory embedded with the crew, learning about their daily tasks (focused on data collection and communication, climate, weather, and instrumentation), and report their findings back to their classrooms via a variety of formats. Classroom projects and investigations are tested on the summit and serve to enhance student comprehension in several disciplines. Each teaching pair is responsible for an essay-based blog post to be written prior to and just after completion of the program with a goal to explore expectations and reflections on the program going forward.

PC SMART Metric 11, STEM K-12 Activities on a College Campus (Target exceeded): There were four on-campus K-12 activities. Tech Camp was held on the UNH campus (summer of 2019). NHTI, White Mountains and Manchester Community Colleges hosted Girls Technology Days, designed to give high school girls an understanding of careers available to young women in STEM Technology fields. The goal is to engage young women in the STEM related fields that are available to them in NH. Girls attending events participated in a variety of hands-on workshops designed to help them explore STEM careers. Girls also heard from women in STEM fields as guest speakers and hosts.

Secondary Elements: Informal Education Projects. These include STEM activities open to the general public and informal educators professional development.

IE SMART Metric 12, Aerospace Festival (Target event met): MSDC offered an aerospace festival for families and individuals, keynoted by former NASA Administrator Sean O'Keefe. MSDC premiered a new planetarium show, *CapCom Go!* The one-day festival engaged over 400 members of the public.

IE SMART Metric 12 & 13, Planetarium Show rentals, Development of new exhibit, Anniversary of Apollo XI Moon Landing (Targets met): MSDC rented the National Geographic produced planetarium show *The Wildest Weather in the Solar System*. For the Apollo XI lunar landing anniversary, *CapCom Go!* was rented in lieu of the proposed *Moons: Worlds of Mystery.* Participating in the national celebration of the 50th anniversary of the

Apollo 11 moon landing, through creation of "To the Moon", an exhibition on Earth's Moon. "To the Moon" includes the following components: Shackleton Station, an 'underground' lunar colony in a lunar lava tube, complete with workspaces and living spaces and remote-controlled lunar surface activities; an 81-square foot lunar puzzle created with LROC imagery; Mercury, Gemini and Apollo era memorabilia; a toddler lunar space exploration area; upgrade to MSDC's lunar landing simulator; display of entries to a statewide K-12 student lunar art contest; an enhanced Makerspace with 3-D printed Apollo landing sites; current lunar science displays with content from the LRO CRaTER team and imagery from LROC; a meteorite workshop; and participation in NHPBS documentary, *New Hampshire in Space*. Additional activities are scheduled for November/December 2019. The opening celebration on July 20, 2019, was attended by NH Governor Chris Sununu and former NH Governor John H. Sununu, U.S. Senator Jeanne Shaheen, and NH Space Grant Director Dr. Toni Galvin. It included interactive STEM stations for children and families; special programs by NHPBS; the premiere of *NH in Space*; a presentation of *CapCom Go!*, a planetarium show on the Apollo program; tours of "To the Moon"; viewing of the sun via solar/solar-filtered telescopes; and model rocket launches.

The festival, anniversary, Super Stellar Fridays, and planetarium shows engaged more than 10,000 people, of which 3300 were K-12 students.

IE SMART Metric 15, Professional Development (Target met): In September 2018, the MSDC Executive Director and Education Director participated in the ASTC annual meeting in Hartford, CT. The Executive Director also participated in a gathering of executive and education directors from science museums throughout the Northeast U.S. at the Museum of Science in Boston, MA.

IE SMART Metric 16, Support a public series of STEM programs involving high school and community college students to create planetarium show components (target not started in reporting period.) This was part of the augmentation proposal, with a timeline starting in the fall 2019.

II. PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE GOALS:

- **Diversity**:

The NHSGC institutions are geographically distributed across the State and include underserved rural and urban communities. The institutions represent 4-year and 2-year colleges, research institutions of higher learning, and non-profit STEM organizations. On the consortium management during FY19, the Consortium director and two affiliate directors or assistant directors (Community Colleges, and the McAuliffe-Shepard Discovery Center) are female.

SMART Metric 2 (Targets met): Of the 102 students receiving direct funding, 46% were female.

SMART Metric 1 (Targets partially met): of the 102 students receiving direct funding, 13.7% were from under-represented minority and ethnic groups. This exceeds the state's college and university on-campus minority representation, which is around 9%, but was less than our internal goals.

- **Minority Serving Institution Collaborations**: none
- **Office of Education Annual Performance Indicators**:

API 3.3.3: STEM-18-1 Significant, direct student awards = 55; Minority/ethnic under-represented = 6 Female = 24; Disabled = 4

API 3.3.5: STEM-18-5 Number of presentations at professional conferences: 19

IMPROVEMENTS MADE IN THE PAST YEAR:

MSDC was able to engage two industry partners and a charitable foundation in sponsoring its Apollo Exhibit.

CURRENT AND PROJECTED CHALLENGES:

We have had some issues with aligning the funding cycle of this one-year award with university cycles, in particular for guaranteeing graduate student stipends and hiring early-career post doctorates. Dartmouth College is on a quarter system, while PSU, UNH, and Community Colleges are on a semester system (but each institution with different start dates for their semesters). In addition, it does take time for all the one-year subawards to go through processing. Dartmouth is continuing its search for a YVS in the fall but may need to extend to spring quarter. Due to one student declining a fall fellowship, UNH has a few thousand dollars left in tuition it would like to use in the Spring semester. Due to these factors, we anticipate asking for a no-cost-extension such that we may conclude these items in the spring.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION:

The University of New Hampshire (UNH) is a public institution in Durham, NH, and is the lead institution for Land, Sea, and Space Grants in NH. Students from any space-related discipline are eligible to apply for Space Grant fellowships, faculty/staff mentored student research, NASA internships, and student project and travel support. Space Grant also may support summer STEM Camps on the UNH main campus.

Dartmouth College, in Hanover, NH, is a private Ivy League school. Space Grant serves three academic departments (Physics and Astronomy, Thayer School of Engineering, and Earth Sciences) and the Women in Science Project (WISP). Programs are centered on fellowships, student research, student project and seminar travel support.

Plymouth State University (PSU) is a public institution located in the White Mountains area. Space Grant activities are focused on students in the Judd Gregg Meteorology Institute (JGMI), a center for applied atmospheric science research. Space Grant programs are centered on scholarships, fellowship(s), student travel, and faculty development support.

The Community Colleges of New Hampshire Foundation is a non-profit organization working with the Community College System of New Hampshire (CCSNH). Seven colleges, intwelve

locations throughout the state, offer associate degree and certificate programs. STEM scholarships are offered at all of the colleges. The Foundation also engages in pipeline activities, such as K-12 career days and STEM camps. The community colleges are:

- White Mountains Community College, located in Berlin, Littleton, and North Conway.
- River Valley Community College, located in Lebanon, Keene, and Claremont.
- Lakes Region Community College, located in Laconia.
- NH Technical Institute (NHTI), located in Concord.
- Great Bay Community College, located in Rochester and Portsmouth.
- Manchester Community College, located in Manchester.
- Nashua Community College, located in Nashua.

The McAuliffe-Shepard Discovery Center (MSDC), a non-profit organization located in Concord, NH, is an air and space museum that also hosts NASA's Education Resource Center (ERC) in the State. MSDC engages in Space Grant general public activities such as aerospace festivals, exhibits, and planetarium shows, and informal educator professional development. MSDC may also provide STEM camps for K-12.

The Mount Washington Observatory (MWO) is a private non-profit research organization located in the White Mountains, featuring a mountaintop weather station and observatory (elevation: 6,288') conducting scientific research on extreme weather. Their Space Grant activities include pipeline K-12 in-person and distance learning and teacher workshops.

BAE Systems, Inc. is a U.S. corporation with an international footprint and has facilities in New Hampshire. BAE Systems is an unfunded industrial affiliate that often partners with UNH and MSDC. BAE Systems provides scholarships to high school students to attend UNH's Tech Leaders summer program. This program features both a camper-selected, two-week long engineering project and leadership and entrepreneurship activities for students with an interest in STEM. In addition, several Engineering employees help to develop the curriculum, working with UNH to help prepare students for STEM careers of the future. BAE Systems has enjoyed a long-standing strategic partnership with FIRST® Robotics (headquartered in Manchester, NH) - supporting both the FIRST® Lego League (FLL) and the FIRST® Robotics.