Sea Grant
Lake Champlain








Briefing Book

Institutional Status Proposal and Site Review

Burlington, VT

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Contents

Acronyms

CAP — Coherent Area Program

CALS — College of Agriculture and Life Sciences at UVM

CAS — College of Arts and Sciences at SUNY-P

ECHO — Echo Leahy Center for Lake Champlain

EPSCoR — Experimental Program to Stimulate Competitive Research

FLW Outdoors — Fishing League Worldwide Outdoors

GLSG — Great Lakes Sea Grant network

LCBP — Lake Champlain Basin Program

LCRI —Lake Champlain Research Institute at SUNY-P

LCSG — Lake Champlain Sea Grant

LCMM —Lake Champlain Maritime Museum

MOU — Memorandum of Understanding

NESG — New England Sea Grant network

NGO — Non-governmental Organization

NOAA — National Oceanic and Atmospheric Administration

NSF — National Science Foundation

NSGAB — National Sea Grant Advisory Board

NSGO — National Sea Grant Office

NSGCP — National Sea Grant College Program

NY BASS — New York Bass Anglers Sportsman Society

NYSG — New York Sea Grant

OAR — Ocean and Atmospheric Research, a division of NOAA in which the NSGCP is funded

PAC — Program Advisory Committee (of the LCSG)

PI — Principal Investigator

RFP — Request for Proposals

RSENR — Rubenstein School of Environment and Natural Resources

SC — Steering Committee (of the LCSG)

SGA — Sea Grant Association (of national Sea Grant programs)

SPA — Sponsored Projects Administration at UVM

SRT — Site Review Team

SUNY-P — State University of New York at Plattsburgh

TMDL — Total Maximum Daily Load

UVM — University of Vermont

VTDEC — Vermont Department of Environmental Conservation

WA — Watershed Alliance

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Lake Champlain Sea Grant: Background, overview, and context

Vision: We envision a future in which communities anticipate and enable change for long-term ecosystem health and sustainable economic development.

Mission: To develop and share science based knowledge to benefit the environment and economies of the Lake Champlain Basin. Our audience comprises business, state, and local leaders and the communities they serve.

Background

The Lake Champlain Special Designation Act, part of the Great Lakes Critical Programs Act of 1990, led New York Sea Grant Extension (NYSG) to offer limited outreach support and educational programming to residents of the Lake Champlain Basin. The 1998 Sea Grant Reauthorization Act provided the opportunity to create a Lake Champlain Sea Grant outreach project (LCSG). The original proposal (Appendix A) stressed that the focus was to be "a Lake Champlain Sea Grant Outreach Program, not a New York and a Vermont outreach program, but a basinwide coordinated effort." We have adhered to this model while we have grown our program. Through partnership between the University of Vermont (UVM) and the State University of New York at Plattsburgh (SUNY-P), plus other organizations in the basin, we actively operate in a lake catchment that includes New York, Vermont and Quebec Province. The Lake Champlain basin lies within the Laurentian-Great Lakes drainage. We share close environmental, social, and economic ties with the Great Lakes Sea Grant programs, with whom we associate. Geographically we are also closely associated with the New England Sea Grant programs on topics of mutual interest.

Initially, LCSG consisted of two specialists with an ambitious charge to provide education and outreach on critical challenges, including "water quality, non-point source pollution, sustainable development in the coastal region, coastal economic development, recreational fisheries, and aquatic exotic species." Its early successes led to designation as a Sea Grant Coherent Area Program (CAP) in 2012 (Appendix B). Dr. Leon Cammen, then Director of

Figure 1. Timeline of LCSG history

the National Sea Grant College Program (NSGCP), in his letter of decision (August 9, 2012) noted that "The Lake Champlain Sea Grant project has earned this designation for demonstrating a strong core of capabilities in research, extension and education, and applying this competence to regional challenges and opportunities."

In 2015, we hosted an external, NSGCP-led site review as part of the national program then underway in preparation for the Performance Review Process. With the guidance of Interim Director Nikola Garber, we used this mechanism to assess our readiness to propose Institute status. The site review report (Appendix C) concluded that "the LCSG Coherent Area Program partnership meets the standards of NOAA's Sea Grant program and has demonstrated the potential to begin the process of becoming an institutional program." The 2015 Site Review Team made four recommendations and one suggestion. We have addressed these and provide details in reference to Criterion 10 — Continued High Performance.

Context

Lake Champlain is among the largest freshwater bodies in the United States and is a highly valued international resource. As reported in the National Sea Grant College Program document *Policy for the Allocation of Funds*, FY 2014 and Beyond (September 23, 2014) the Vermont and New York portions of the Lake Champlain basin are home to nearly 500,000 people, more than the coastal populations of New Hampshire, Minnesota, and Guam. If we include our Québec partners, this population exceeds 600,000 (EPA), ahead of Sea Grant jurisdicitions in Alaska and Georgia and on par with Oregon. At least 35 percent of this population relies on the lake for drinking water (LCBP Basin Facts). Its shoreline is 587 miles long, longer than the shorelines of Rhode Island, Delaware, Ohio, Minnesota, Pennsylvania, New Hampshire, Guam and, Illinois/Indiana. Many people who live in the basin are dependent on the lake for jobs, recreation and overall quality of life. People from around the world visit the area to enjoy its cultural and military history, abundant biological resources, and opportunities for recreation and renewal.

LCSG offers education, outreach and applied research to enhance the sustainable use, restoration, and development of the lake's ecosystem. Since its inception, it has sought to improve the economic and environmental vitality of the Lake Champlain Basin by building strong partnerships with communities, businesses and schools. Our programs inform the watershed's inhabitants and visitors about those actions needed to protect Lake Champlain's waters, the basin's coastal region, and other natural and cultural resources. LCSG also offers research based outreach programs for sustainable business development, which generates income and support for important resource protection goals.

The LCSG Program is well-poised to move to Institute Status in the National Sea Grant College Program (NSGCP). We have satisfied our "time in grade" requirement as a CAP program. The criteria that quantify "need" within NSGCP (basin population and shoreline miles) is consistent with other Sea Grant Institutes. More important is our demonstrated ability to identify needs, work with partners, develop projects, run RFPs, seek matching funds, and deliver products that have meaningful outcomes for our partners and stakeholders, as summarized in this Briefing Book. We have been good stewards of the funds entrusted to us and have proven our ability to grow the LCSG program. Our plan for the components of an Institute proposal builds on our strengths, is responsive to stakeholders' needs, and has the strong backing of our partners. The sections that follow address the ten essential criteria that the NSGCP has identified as necessary for a successful Sea Grant Institute. We look forward to discussing these criteria and our plans with the Site Review Team.

Criterion 1 — Leadership

The Sea Grant Institute candidate must lead both intellectually and in practice in science, engineering, education, and advisory service in the Lake Champlain Basin.

Context

The Lake Champlain Sea Grant (LCSG) is recognized as a leader in the region and beyond. From modest beginnings as an outreach project of the New York Sea Grant program, LCSG has grown into a mature program that presents an array of information and services. We operate in a vibrant landscape that offers numerous opportunities for work, entrepreneurship, and recreation. This also creates a complex web of interacting challenges for land and water management. We fund research, offer advisory services, and provide educational opportunities to meet these challenges. Our core is a partnership between the two largest state-funded institutions of higher learning in the Lake Champlain watershed (Figure 2). The University of Vermont, with UVM Extension focuses on the eastern portion of the basin. The State University of New York at Plattsburgh, our partner, serves the western region. We coordinate our operations so that all staff work across the entire basin.

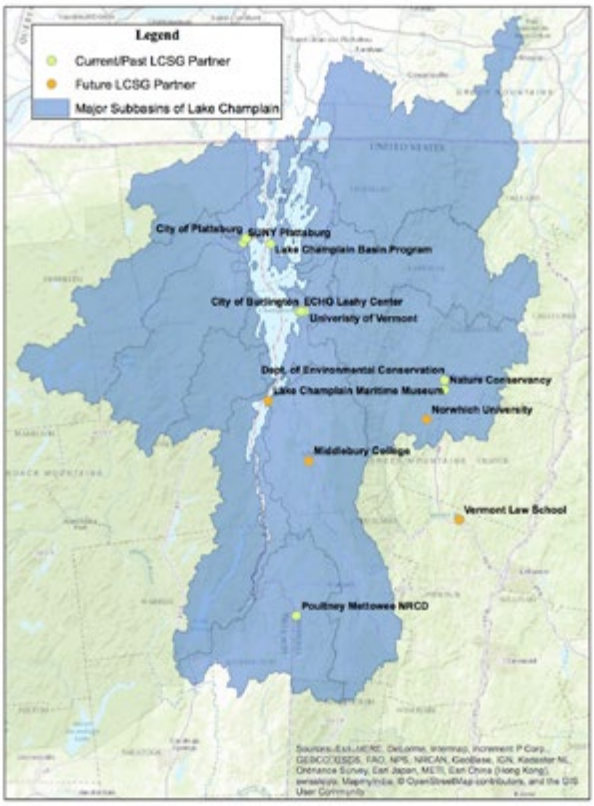


Figure 2. Lake Champlain Basin and key partners. The Lake Champlain Basin occupies most of the western portion of Vermont and a large portion of eastern, upstate New York as well as a small portion of southern Quebec. Source: Lake Champlain Basin Program

The University of Vermont

The University of Vermont (UVM) is the largest and most diverse institution of higher education in the region. UVM is an R2 research university that offers a wide range of baccalaureate, MS, and Ph.D. programs in environmental sciences, engineering, biological sciences, policy and social sciences, medical public health sciences, and business innovation and entrepreneurship. It hosts organizations relevant to LCSG, including the Gund Institute for the Environment, the Center for Rural Studies, the Vermont Complex Systems Center, and the Vermont Genetics Network. Its Rubenstein School of Environment and Natural Resources (RSENR) is the primary host for LCSG. RSENR

"LCSG has become the "go-to" organization for technical expertise on green infrastructure and LID in the Champlain watershed. The Lake Champlain Basin Program and LCSG often partner together on programming, but we also rely on each other to cover certain issues. Green infrastructure is one for which we can count on Sea Grant."

~Eric Howe, LCBP Executive Director

also hosts the Rubenstein Ecosystem Science Laboratory (RESL) that operates the R/V *Melosira*. RESL houses cutting edge research and teaching facilities for the study of aquatic ecology and watershed sciences. Research at RESL employs a suite of observational, experimental, and modeling approaches to understand ecological processes for basic and applied ends. LCSG's Watershed Alliance program and the Watershed Research Laboratory are both housed in RESL.

The State University of New York at Plattsburgh

The State University of New York at Plattsburgh (SUNY-P) offers baccalaureate and master's degrees in Arts and Sciences, Business and Economics, and Education, Health, and Human Services. SUNY-P is the associate host for LCSG and hosts the Lake Champlain Research Institute (LCRI), which is housed in the College of Arts and Sciences. LCRI provides students with research experiences as part of their career preparation. It involves qualified students as research assistants on funded projects. LCRI has an advanced analytical instrumentation lab and maintains research vessels that complement the Vermont facilities.

LCSG Staff

The leadership capabilities of LCSG are most evident in the experience and capabilities of our staff. They are actively involved in an array of committees and working groups that relate directly to the strategic interests of our program. State agencies, local community leaders, and regional NGOs regularly seek the involvement of LCSG staff on initiatives of mutual interest (Table 1). We provide additional details about roles and experiences of LCSG staff in Criterion 2 — Organization, next.

Table 1. LCSG staff leadership roles

Institutional

- UVM Gund Institute for the Environment Development Committee, Member
- RESL Strategic Planning Team, Member
- UVM Communicators Network, Member

State

- VT EPSCoR Basin Resilience to Extreme Events research team, Senior Adviser
- VT Water Quality Advisory Board, Member
- VT Hazardous Materials Advisory Board, Member
- VV Green Infrastructure Roundtable, Chair
- VT Arts Council Review Committee, Member
- VT Guide to Stormwater Management - Member
- Resilient Rights of Way Advisory Board and Urban Focus Team, Member
- VT State-Wide Environmental Education Programs (VT SWEEP), Board of Directors
- VT Learning for the Future Project, Member
- VT Water Resources and Lake Studies Center, Director
- Watersheds United Vermont Steering Committee, Member

Regional

- LCBP, Technical Advisory Committee, Member, past Chair
- GLSG Network Directors, Coordinator
- LCBP, Steering Committee, Member
- Leahy Summits for Lake Champlain Planning Committee Member
- Lake Champlain Clean Water Network initiative Common Circle (Leadership Team), Member
- Clean Water Network Public Awareness, Team Lead
- NSRC, Theme 1, Director
- LCBP, Education and Outreach Committee, Member
- GLSG Network Extension Program Leaders, Chair
- Northeast Aquatic Nuisance Species Panel, Member
- IJC Lake Champlain Richelieu River Study Board's Public Advisory Group, Member
- GLSG Network Communicators, Member
- GLSG Network Research Coordinators, Member
- Center for Basin Education Initiative (CBEI), Member
- New England Environmental Education Association (NEEEA), Member

National and International

- National Water Quality Monitoring Council Education and Outreach Working Group, Member
- National Water Quality Monitoring Council Volunteer Water Monitoring Working Group, Member
- Assembly and Communicators Meeting Planning Team, Member
- NSGCP Green Infrastructure Community of Practice Leadership Team, Member
- NSGCP Communicators Network, Member
- NSGCP Research Coordinators Network, Member
- NSGCP Fiscal Officers Network, Member
- NSGCP Educators Network, Member
- Citizen Science Association, Chair of the Board

Criterion 2 — Organization

The Sea Grant Institute candidate must have created the management structure essential to achieve a viable, productive Sea Grant Program, and must have administration backing sufficient to fulfill its multidisciplinary and multifaceted mandate.

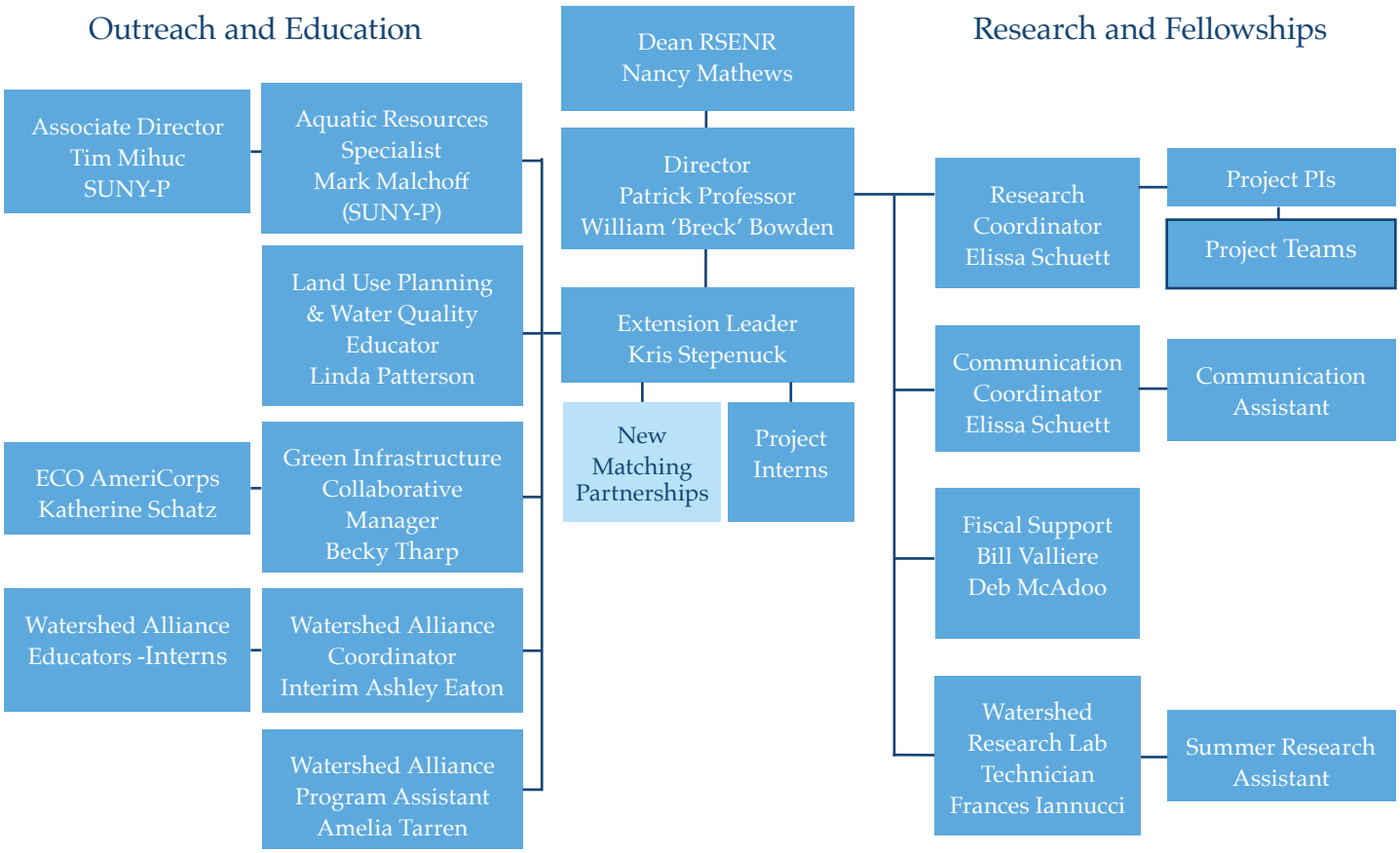
Overview

The Director is a member of the Rubenstein School of Environment and Natural Resources faculty (UVM). The LCSG Co-Director is a faculty member of the College of Arts and Sciences (SUNY-P). Extension activities of the LCSG program are developed and coordinated by the Extension Leader, a faculty member of RSENR. The Research Coordinator facilitates the research process. Four full-time staff facilitate outreach programming throughout the Lake Champlain Basin. They develop relationships with partners and stakeholders to empower communities, businesses and other organizations to make informed decisions regarding conservation, utilization and restoration of their aquatic resources for long-term environmental health and sustainable economic development. LCSG program staff collaborate to review progress and develop or respond to new initiatives. The Communications Coordinator works closely with these staff to reach the public and other audiences. The organizational structure of LCSG is presented in Fig. 3. Biosketches for LCSG staff are in Appendix D.

Strategic Planning

Strategic planning for LCSG is conducted through consultation with stakeholders, guidance from a Program Advisory Committee (PAC) of major collaborators, and input from a Steering Committee (LCSG-SC). The responsibilities of PAC and LCSG-SC are described in detail in a "Comprehensive MOU for the LCSG" (Appendix E).

Figure 3. Organizational chart



Program Advisory Committee

The PAC provides regular guidance to the LCSG program. PAC members represent stakeholders from New York and Vermont, and include businesses, agriculture, watershed organizations, state and federal government, research, and education. The PAC ensures that LCSG outreach and education programs address the priorities of basin communities, businesses, and policymakers. Committee members meet at least biannually to set priorities, review activities and accomplishments and advise on program development. LCSG staff maintain ongoing relationships with PAC members in their area of interest.

Current LCSG PAC members

- Dan Albrecht, Chittenden County Regional Planning Commission
- Jill Arace, Vermont Association of Conservation Districts
- George Burrill, Retired - international development
- Kari Dolan, Water Quality Division, VTDEC
- Phelan Fretz, ECHO, Leahy Center for Lake Champlain
- Eric Howe, Lake Champlain Basin Program
- Craig Heindel, Waite-Heindel Environmental Management
- Jim Jutras, Village of Essex Water Quality Superintendent
- Crea Lintilhac, Lintilhac Foundation
- Eric Smeltzer, VT DEC, retired
- Mike Winslow, VT EPSCoR

"The fact that the LCSG provides opportunities across the campus is especially welcome as we build even greater capacity for integrated and transformative STEM education and research at UVM. I look forward, for example, to evolving interactions between the LCSG and the newly established Gund Institute for the Environment at UVM."

~ David Rosowsky, Provost, UVM

Steering Committee

In recognition that the LCSG is a bi-state and bi-institutional partnership, the LCSG Steering Committee includes the Vice President for Research at UVM, the Dean of the Rubenstein School of Environment and Natural Resources, the State Director of Extension at UVM (on behalf of the Dean of the College Agriculture and Life Sciences at UVM), and the Dean of the College of Arts and Sciences at SUNY-P. Director Bowden maintains contact with these Board members and convenes them as needed to address high level program guidance. Biosketches for the LCSG-SC members are provided in Appendix F.

Steering Committee members

- Dr. Richard Galbraith, Vice-President for Research and Graduate Education, UVM
- Dr. Nancy Mathews, Dean of the Rubenstein School of Environment and Natural Resources, UVM
- Chuck Ross, State Director of Extension, College of Life Sciences and Agriculture, UVM
- Dr. Andrew Buckser, Dean of the College of Arts and Sciences, SUNY-P

High-level Institutional Support

Appendix G has letters of support from the Provosts of UVM (Dr. David Rosowsky) and SUNY-P (Dr. Michael Morgan, Interim).

"Our mission complements that of the LCSG very well. We look forward to future opportunities for our students to work on LCSG-funded research and outreach projects. In particular, we see opportunities to expand the Watershed Alliance program that has been so successful in Vermont, to the New York side of the Lake.

~ Michael Morgan, Interim Provost, SUNY-P

Criterion 3 — Relevance

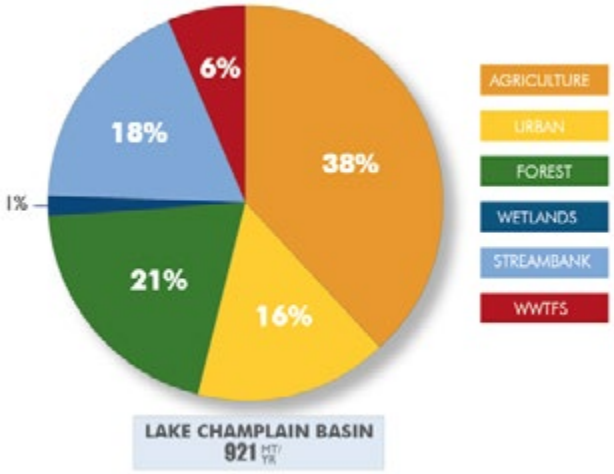
The programs of the Sea Grant Institute candidate must be relevant to local, state, regional, and national opportunities and problems in the Lake Champlain Basin. Important factors are the presence of an emphasis on Lake Champlain resources, and the extent to which capabilities have been developed to be responsive to that need.

Overview of issues faced in the Lake Champlain Basin

The land-to-water ratio of the Lake Champlain watershed is approximately 18:1 (Figure 2). This is very high compared, for example, to the Great Lakes, which have land-to-water ratios less than 4:1. Consequently, human use of the land on Lake Champlain influences water quality greatly. Like other inland water bodies, Lake Champlain is primarily affected by nonpoint sources. Phosphorus, suspended sediments and associated algal blooms, chloride, bacteria and other pollutants carried in stormwater are the primary stressors of concern. Lake quality is also harmed at times by combined sewage overflows. These stressors have significant economic impacts. For example, property values recently decreased in the northeast arm of the lake, apparently in response to an increase in algal blooms (Appendix H). A recent study reported that the state would lose $16.8 million in economic activity and 200 full-time summer jobs for every meter of water clarity lost (Appendix I). While Vermont passed a Clean Water Act in 2015, and EPA approved the state's revised Total Maximum Daily Load (TMDL) pollution reduction strategy for phosphorus in 2016, numerous actions are needed to improve water quality across land use sectors in the basin. Highest priority projects are identified in Vermont's TMDL Phase I Implementation Plan. Agricultural and forested lands dominate the basin area, but various studies show that developed lands generate a proportionately large fraction of the total phosphorus load to the lake despite being smallest area (Figure 4). While many federal, state and local organizations focus their efforts on agricultural issues, fewer concentrate on urban and suburban developed lands.

With over 80 marinas and 40 public boat landings

Figure 4. Agricultural and forested lands dominate the basin, but urban areas have been identified to contribute a significant amount of phosphorus as compared to other land use types.



on Lakes Champlain and George, the impact of aquatic invasive species on biodiversity is another notable concern in the watershed. To date, Lake Champlain has 50 known invasive species, the latest being the spiny water flea (*Bythotrephes longimanus*). First sighted in 2014, this species has since been found throughout the lake. While there are fewer invasive species here than the 184 known within the Great Lakes, Lake Champlain is the largest freshwater east of Lake Ontario, and a popular destination for recreational anglers. In addition, over 100 bass tournaments are held here annually. These events are economically important and attract participants from across North America. The lake is also connected via the Champlain Canal to the Hudson River Basin and lies within southern Quebec. These factors increase risk of introduction by other invasives, which threatens the sustainability of native fisheries and economic benefits derived from them. Lake warming due to long-term climate change is likely to increase the risk of invasion and may favor alien species already present.

Frequent extreme precipitation events have increased significantly within the watershed. This has caused damaging shoreline inundation and erosion. In turn, homes and infrastructure are threatened and spawning areas may be reduced, which would harm the lake's fisheries. It can also increase risk of encroachment by invasive species along shorelines. In 2011 record high water levels caused inundation, shoreline erosion, and widespread physical and economic damage to coastal homes and businesses in New York, Vermont, and Quebec. Later that year, Tropical Storm Irene brought five to 11 inches of rain to areas of the basin within a 24-hour period. Over $730 million in flood loss occurred in Vermont alone, damaging more than 800 buildings, 500 miles of roads, and 300 bridges. Models indicate future such events are likely to occur more often. Although the Federal Emergency Management Agency (FEMA) produces inundation maps, 60-70% of flood damage here is due to fluvial erosion outside FEMA flood hazard areas. Consequently, development within river corridors and floodplains, and stream channel alterations have dramatically increased property and infrastructure losses from flooding. Without guidance and investment, these damages are likely to continue.

Microplastics and crude oil transport are emerging new threats in the basin. Microplastics have garnered worldwide attention following recent "microbead" bans in personal care products. However, microbeads are not the only source of microplastics in freshwater. They are derived from the breakdown of larger pieces, including litter. Microfibers from synthetic fabrics such as fleece clothing have also been implicated. Wastewater treatment plants are unable to filter microplastics less than five mm. These byproducts can leach harmful chemicals into the environment. Heavy metals adhere to them. Further, wildlife often consume them, which transports toxins up the food chain.

Transport of crude oil and other harmful industrial products forcefully drew attention after the Lac Mégantic derailment disaster of 2013. The entire western edge of Lake Champlain has a rail line over which up to 25 trains, each carrying 3.6 million gallons of Bakken crude oil, travel each week. This line comes within a few meters of Lake Champlain. A spill could wreak havoc on the aquatic ecosystems and would put at risk the drinking water of thousands.

Relevance of current research program to local, state, regional and National needs

LCSG is or has been involved in research, training, and outreach associated with the issues just noted. In subsequent sections we will describe in detail our efforts in education and training (Criterion 5), advisory services (Criterion 6), and research productivity (Criterion 8). Here we briefly describe how we have focused our resources on local, state, regional, and national initiatives.

Everything we do focuses on the environment and economy of local communities. For example, our workshops on flood resilience help volunteers, community leaders, and homeowners better understand how to retrofit existing structures and plan new development that will meet the challenges from future precipitation and flooding that are likely to occur. Workshops for realtors help them understand the connections between environment and property value, and how better development practices can benefit both. Our outreach to hosts and participants in fishing derbies raises awareness of clean and safe boating practices that reduce pollution and the risk of spreading aquatic invasive species.

LCSG works closely with state agencies to define priority research and identify outreach opportunities. Our most durable collaboration has been with the Vermont Department of Environmental Conservation (VTDEC) within the Vermont Agency of Natural Resources. Executive staff in VTDEC sit on the Program Advisory Committee of LCSG and have helped define our research RFPs and evaluate proposals. Among our most important collaborations is a 50:50 shared position with VTDEC to manage the Vermont Green Infrastructure Roundtable (GIR). This is a multi-agency effort to coordinate green infrastructure practices across all

of the state's activities.

LCSG staff are deeply involved with regional initiatives. The Lake Champlain Basin Program (LCBP) is a Congressionally mandated, EPA funded initiative to restore and protect Lake Champlain and its watershed. LCBP partners with agencies and organizations in New York, Vermont, and Québec to coordinate efforts to address challenges of phosphorus pollution, toxic substances, biodiversity, aquatic invasive species, and climate change. Consequently, the missions and visions of LCBP and LCSG are closely aligned. The LCSG Director (Bowden) has a seat on the LCBP Steering Committee and sits on (and Chaired) the LCBP Technical Advisory Committee. The LCSG Extension Leader (Stepenuck) is a member of the LCBP Education and Outreach committee. This enables us to utilize our resources most effectively to address the issues noted above, all of which regard common interests. LCSG is geographically aligned with the New England Sea Grant network; we collaborate with their programs of common interest. LCSG is operationally closely aligned with the Great Lakes Sea Grant network and most actively participates with them, given our common interests. Bowden chairs the GLSG Committee of Directors and Stepenuck chairs the GLSG Assembly, both rotating positions.

The issues we face in the Lake Champlain basin are all national, even international. In particular, our work on nutrient enrichment, algal blooms, and aquatic invasive species all relate to national priorities for water resources management. Our work on the emerging issues of microplastics and crude oil transport also engages national and international priorities. In Section 2 on Leadership (Criterion 1) we identify ways in which we have been involved, at the national level, to address these "wicked problems."

Criterion 4 — Programmed Team Approach

The Sea Grant Institute candidate must have a programmed team approach to solve challenges faced by the Lake Champlain basin, including relevant, high quality, multidisciplinary research with associated educational and advisory services capable of producing identifiable results.

LCSG uses a programmed team approach to address the needs of the basin communities. We fund research that our partners and stakeholders identify as important. LCSG staff work with researchers and utilize literature to provide scientific knowledge that can be adopted by municipalities, businesses, educational institutions, and citizen based organizations to make informed decisions.

Finally, we extract the significant lessons from this knowledge to develop a variety of outreach and education programs for schools and adult learning communities. Here we present an overview of our programmed team approach. Greater detail will follow in subsequent sections.

Research — The Foundation for Advisory Services and Education

Research we facilitate relates directly to significant issues in the Lake Champlain basin and to the LCSG Strategic Plan. Several factors guide decisions about where and how we invest our research efforts. We understand the broad range of needs because we are deeply involved through numerous local, state, regional, and national committees that develop research priorities; see, for example, Leadership (Criterion 1). We further refine investments through informal dialog with major partners (e.g., the Vermont Department of Environmental Conservation) and more formal discussion with our Program Advisory Committee (PAC). Other programs unique to UVM and the basin also influence our decisions on research investments. We explain these in detail in reference to Criterion 8 — Productivity.

Advisory Services — The Foundation for Sound Decision Making

LCSG develops workshops and programs that provide knowledge to help community and business leaders and property owners make informed decisions about issues facing the Lake Champlain region. We elaborate on our extension and advising initiatives in reference to Criterion 5 — Advisory Services. Briefly, as a consequence of our involvement in local, state, and regional committees (see Criterion 1 — Leadership) and through communication with the LCSG PAC, we are in close contact with stakeholders and can assess their needs. In some cases we utilize existing information to develop new resources that anticipate stakeholder needs. Specific examples are our initiatives to provide information about green infrastructure and to develop comparative flood inundation maps. We also fund projects that generate new information that we can share with stakeholders. Examples include our early research on sustainable sports fishing in Lake Champlain and our most recent work on microplastics.

Recently we developed a unique vehicle to provide science based knowledge to our stakeholders. Many of them, especially in state agencies, possess considerable scientific literacy. However, they often bemoan how little time they have to keep current with scientific literature. In response, LCSG has partnered with several other programs to produce a quarterly digest of recent scientific literature that is relevant to regional environmental management issues. This report — ecoNEWS VT — is not a newsletter. Rather, it summarizes findings of peer-reviewed literature that are either about the Lake Champlain region or relevant to it. We describe this publication in greater detail in Criterion 6 — Advisory Services.

Education — The Foundation for the Future

The information we develop for advisory services is typically designed to synthesize technical knowledge that will address specific needs of stakeholders. However, there are general principles and useful examples embedded in these technical knowledge bases that are useful generally, including to school age children. In addition to the Watershed Alliance, LCSG staff partner with other programs that engage school children by adding curriculum that focuses on lake related issues. Examples include the Burlington Community Sailing Center programs, which are designed for students, and the Champlain Basin Education Initiative: Watershed for Every Classroom program, aimed at educators. We describe our education and training programs in greater detail, next, in reference to Criterion 5.

Criterion 5 — Education and Training

Education and training must be clearly relevant to National, regional, State and local needs in fields significant to the Lake Champlain Basin.

Lake Champlain Sea Grant offers numerous educational opportunities aimed at audiences of specific ages. Our flagship education program is Watershed Alliance, which is designed to increase knowledge and stimulate actions that address the challenges of land and water management in the basin with sound science. We also work with state agencies, nonprofit organizations, watershed groups and business associations to build environmental literacy for all basin citizens. Table 2 provides a summary of programs we have offered through LCSG in the last five years. Below we highlight two of them.

Watershed Alliance

Watershed Alliance provides K-12 students with hands-on watershed education in the classroom, in tributaries, and on Lake Champlain. LCSG staff and undergraduate interns serve as instructors for participating schools and youth groups, utilizing a curriculum aligned with Next Generation Science Standards.. Thousands of students have been educated through its three programs (Table 2).

WA serves as a strong workforce development tool for LCSG as well. Undergraduate interns from several colleges in the basin are provided environmental education training and gain valuable work experience as instructors. WA also trains professional educators directly, as well as in partnership with LCBP's Watershed for Every Classroom. The latter is a yearlong graduate level teacher training program.

Continuing Education Workshops for Real Estate Agents

Real estate agents are in a unique position to influence development decisions that regard water quality. LCSG offers continuing education workshops on topics related to sustainable land use, climate change resilience, conservation opportunities, and state and federal regulations that protect water resources. Over 200 Vermont realtors have attended workshops throughout the basin. Realtors receive materials and resources that enable them to guide property owners toward responsible stewardship choices. Realtors are awarded two continuing education credit hours per workshop for professional licensing requirements. This training helps protect valuable shoreline resources through a business community that has a mutual interest in an attractive and functional environment. We think this type of training can be extended to other business sectors; e.g., developers, mortgage bankers, and appraisers.

Figure 5. Location and number of participants in Watershed Alliance programs

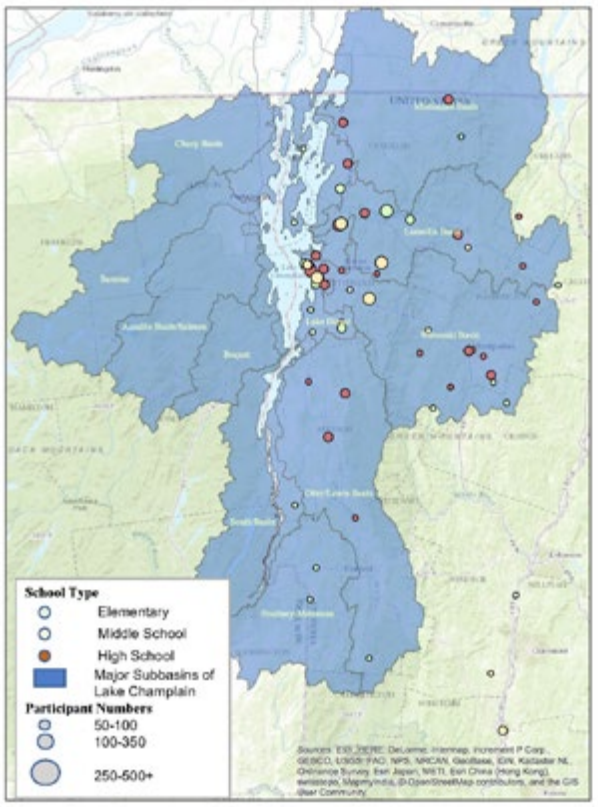


Table 2. Summary of selected educational programs offered by LCSG.

Program Name	Audience	Brief Description	2012-17 People Reached
K-12 Educational Programming			
Stream Monitoring and Stewardship	K-12 students and teachers	A multiday in-class, in-stream, and community based educational experience.	6,000
Lake Champlain Live	K-12 students and teachers	A two-hour research trip on Lake Champlain aboard the UVM R/V Melosira	900
Keeping the Balance	K-12 students and teachers	A land-based program to build student understanding of aquatic food webs and human impacts in the watershed.	1,800
Undergraduate Programming			
Watershed Education Internship Program	Undergraduate students	A yearlong paid undergraduate internship in environmental education and watershed science that allows students to build their scientific knowledge and educational skill sets.	36
Adult Professional Development and Training Opportunities			
Watershed Wise Teacher Trainings	K-12 teachers	A precursor to Stream Monitoring and Stewardship, teachers learn about stream ecology and how to facilitate.	80
Watershed for Every Classroom	K-12 teachers	A yearlong graduate level course for K-12 educators that explores how to teach water quality.	45
Vermont Use Appraisal Program	Realtors	Land use program to protect land from development using tax incentives for farmers, foresters and conservationists	129
Demystifying FEMA and Floodplain Maps	Realtors	Online mapping resources to identify flood hazard areas, river geomorphology, and National Flood Insurance Program guidelines	209
Vermont Shoreland Protection Act	Realtors	Shoreland Protection Act regulations, permit processes, natural shoreland erosion control methods	44
Water Resources for Realtors	Realtors	Identifies significant water resources, potential benefits and challenges to property owners using online mapping tool.	48
Web-Based Mapping	Realtors	Tools for using VT Natural Resources Atlas for mapping lot lines, waste sites and wells, FEMA panels and other features.	48
Social Marketing Workshop	Watershed outreach professionals	Two-day workshop to train professionals in proven techniques to change environmental behviors.	35
Making River Corridors Work for You	Conservation commissions, local elected officials	Workshops and materials to educate about protecting floodplains and river corridors from development.	59
Get to Know Our Watershed Tours	General public	A series of tours introduced people to water management through a variety of facilities (e.g. drinking water, wastewater, and hydro plants, green roof and GSI bike tour)	65

Criterion 6 — Advisory Services

The Sea Grant Institute candidate must have a strong program through which information, techniques and research results from any reliable source, domestic or international, are communicated to, and utilized by, user communities. In addition to education and information dissemination, the advisory service program must aid in identification and communication of research and educational needs of user communities.

LCSG provides advisory services to municipalities, educators and schools, businesses, NGOs and the general public across the Lake Champlain Basin. We use our own as well as external research to develop science based information. We conduct frequent surveys to gauge the need for our programs and to quantify knowledge gained by stakeholders. We discussed our advisory services to educators and schools in the previous section on Education and Training (Criterion 5). In the next sections we describe selected advisory services that we have provided to other important stakeholder groups.

Municipalities and State Government

Green Stormwater Infrastructure

LCSG has worked hard to become a leader in green infrastructure research and extension throughout the Lake Champlain Basin. Stormwater management is among the most pressing issues for resource managers in our cold climate and with our particular challenges of nutrient runoff from developed lands. LCSG supported research at the UVM Bioretention Laboratory, directed by Dr. Stephanie Hurley, where bioretention options are studied for their pollutant removal performance. Researchers evaluate how design attributes like soil media and vegetation influence sediment and nutrient removal, as well as potential capture and/or release of greenhouse gases. This work produced data-driven updates to the Vermont Stormwater Manual, where green stormwater infrastructure practices are featured as preferred methods for managing runoff from developed lands.

Another element of the robust programmatic leadership by LCSG is partnership with VT DEC to lead a statewide Green Infrastructure Roundtable. Professionals from academia, design consulting firms, NGOs, state agencies, and municipalities gather to discuss persistent stormwater management concerns and new green infrastructural methodologies to address them. Consistent communication via a green infrastructure listserv educates and informs hundreds of associates of the newest information on green infrastructure practice for water quality.

Road Salt

LCSG was a prominent supporter of the 2016 Salt Summit organized by the Fund for Lake George, and in September 2017 it is co-sponsoring a Deicing Conference in partnership with the Winooski Natural Resources Conservation District. Both events address the issue of chloride accumulation in surface waters via winter maintenance practices. Scientific information from a variety of researchers is shared through presentations and demonstrations for public maintenance personnel and private contractors. These events focus on best practices to minimize the use of sodium chloride and other additives while maintaining safe roads, sidewalks and driveways. LSCG is currently developing a survey of private contractors in the basin regarding their current practices, training experience, motivations to use less salt, and barriers that keep them from doing so. This survey will support an outreach campaign designed to enable private contractors to better manage impervious surfaces in the basin. At the New York Salt Summit, 97 participants developed recommendations for “Best Practices Agreement for Sustainable Salt Use” and work is underway to have all municipalities in the Lake George region adopt these recommendations.

ecoNEWS VT

Academic and government research can be difficult to access, through both awareness of journal articles and an understanding of the science. For this reason we developed ecoNEWS VT to highlight ecological research conducted in Vermont and to serve as a science translator. Since 2014 an online archive of 40+ research digests has been created and quarterly emails with the latest featured summaries are sent to over 300 subscribers. The target audience is users who wish to keep current with research, such as state and municipal

employees, conservation commissioners, and local watershed organizations, as well as members of the public. Partners include the Rubenstein School of Natural Resources, Northeastern States Research Cooperative, Vermont Water Resources and Lake Studies Center, Vermont Monitoring Cooperative and the Vermont Center for Ecostudies.

Businesses

Marinas

Marina-based recreational boaters on Lake Champlain do not regularly have access to educational materials that can build awareness or promote implementation of best practices for clean boating. To address this gap, we surveyed the willingness of marinas to provide educational outreach materials. As a result, over 20 marinas now display educational materials for recreational boaters about AIS spread prevention, display signs to prevent fuel spills and trash contamination, and host monofilament recycling stations.

Fish Tournaments

Research led by LCSG staff to understand the impact of tournaments on the bass fishery has provided advice that we give to tournament organizers to reduce stress on transported fish. This research also led to adoption of a bass tournament management plan signed by the City of Plattsburgh and the Adirondack Visitors Bureau. The plan uses tournament bag weights compiled by LCSG to gauge bass population conditions when deciding how many tournaments to schedule in Plattsburgh the following year.

General Public and NGOs

Low Input Lawn Care

LCSG is developing materials to encourage owners of homes and commercial property to use low input lawn care practices to reduce nutrient and sediment runoff from their properties. These simple recommendations build soil organic matter and promote root growth, which increase soil infiltration capacity and reduce runoff. This summer, an undergraduate fellow, supported by the Simon Family Foundation, will initiate demonstration sites and a research project at several businesses. The objective is to compare soil organic matter, infiltration rates, and (if a drought occurs) visual drought resistance among test plots. Plots will be managed according to the three recommended practices and compared with grass cut to two inches, which represents 52% of Lake Champlain Basin homeowners who maintain their grass at that length. We expect this original research to suppport educational materials that we will make available to stakeholders.

Agriculturally Productive Buffers

Agricultural fields abutting rivers lead to bank instability and flooding from fluvial erosion. The TMDL for phosphorus for Lake Champlain recently reapproved by EPA identified erosion by agriculture and urban streambanks as the second largest source of phosphorus in the lake. Therefore, protecting riparian buffers can reduce phosphorus loading as well as improve flood resilience. However, current state and federal buffer programs do not appeal to some land owners because the contracts are highly restrictive: for many financially struggling small farms, the loss of income-producing property is too great. LCSG, in partnership with the Vermont River Conservancy, has demonstrated the technical and financial feasibility of Agriculturally Productive Buffers (APB). APB promote planting zoned river buffers that allow the production of fruit, nut and forest products while stabilizing vulnerable river banks. The success of this effort is nationally recognized and has been expanded by UVM Extension, The River Conservancy and the National Organic Farmers Association.

Criterion 7 — Relationships

The Sea Grant Institute candidate must have close ties with federal and state agencies, as well as administrations, local authorities, business and industry, and educational institutions. The extent and quality of an institution's relationships are critical factors when evaluating the institutional program.

LCSG works closely with partners in local, state, regional, and federal organizations. LCSG has collaborated with over 230 organizations since 2000 (Appendix J). Some of these relationships have developed into longterm partnerships. LCSG staff often serve on committees and boards to provide leadership and expertise in support of multipartnered projects and programs (see Criterion 1 — Leadership). We also seek guidance from our PAC, which includes members from many of our major partners. The LCSG also draws on their experiences and resources to create working groups that help us meet strategic objectives. These approaches enable us to address the subcriteria associated with this criterion (see text box).

Criterion 7 Subcriteria

- Ensure the relevance of programs
- Give assistance to the broadest possible audience
- Involve a wide pool of talent when providing assistance
- Assist others in developing research and management competence

Federal Agencies

LCSG works closely with the Lake Champlain Basin Program (LCBP), an organization administered cooperatively by the Environmental Protection Agency, the New York Department of Environmental Conservation, Vermont Agency of Natural Resources, Québec Ministère du Développement Durable, and the New England Interstate Water Pollution Control Commission. LCSG works closely with LCBP on projects that promote resilient communities and economies, healthy coastal ecosystems, environmental literacy and workforce development. LCBP funds LCSG initiatives, such as its winter maintenance outreach to private contractors. LCSG staff serve on the LCBP steering, technical advisory, and education and outreach committees, and on the Federal Partners Working Group. In these roles, LCSG contributes to the Opportunities for Action document that defines the work LCBP supports.

> "The relevance of LCSG has increased exponentially over the past 5 years, with limited increases in funding. I continue to see new partnerships developed and strengthened between LCSG and other watershed groups, community groups, and municipalities. LCSG has demonstrated an ability to bring in materials developed by other Sea Grant programs for outreach to private marinas to reduce pollution and address management goals here in the Champlain basin."
>
> ~ Eric Howe, LCBP Executive Director

The Vermont Water Resources and Lake Studies Center (VWRLSC) is supported by the United States Geological Survey (USGS) and is a member of the National Institutes of Water Resources (NIWR). The mission of the VWRLSC is to fund research on major water resource issues of concern to the state, to disseminate results from this research, and to educate students about the nature and value of water resources. An annual RFP is held, and typically funds three to five projects each year, including graduate student projects. Directorship and management of VWRLSC are led by LCSG Director Bowden and Research Coordinator Elissa Schuett. At the national level, the NIWR program and the National Sea Grant College Program are developing stronger connections as a reflection of the overlapping missions of each program.

Regional Networks

LCSG is an active member of the Sea Grant Association, including regional and topical networks and Communities of Practice. We are most closely aligned with the issues of the Great Lakes Sea Grant Network (GLSGN). We participate in regional network meetings, which include hosting the 2015 biannual meeting. Leadership among LCSG staff in the GLSG network is achieved through positions on the Directors and Extension Program Leaders networks. Staff also play roles in regional Communities of Practice and special topic networks. A high priority regional project

has focused on crude oil transport. In support of this project LCSG has led workshops and webinars, and developed the main website for the project. LCSG is coleader of a green infrastructure national community of practice with members from across the national Sea Grant network. The LCSG Research Coordinator (Schuett) has collaborated with other Sea Grant network research coordinators to identify ways to more closely align priorities among research topics when developing RFPs and, possibly, to sponsor a future joint RFP. The LCSG also cooperates regularly with the New England Sea Grant (NESG) network on topics of joint interest. A series of educational webinars are under development by members of a planning team for this network.

The Director of the LCSG (Bowden) is also Director of Theme 1 (Socioeconomics) of the Northeastern States Research Cooperative (NSRC). NSRC is a competitive grant program funded by the USDA Forest Service. It supports cross-disciplinary, collaborative research in the Northern Forest — a 26 million acre working landscape that is home to over one million residents, and stretches from eastern Maine through New Hampshire and Vermont and into northern New York. The NSRC addresses the importance of the Northern Forest to society and the need for research that has relevance and benefits for the people who live there, work with its resources, use its products, visit it, and care about it. The interests of NSRC Theme 1 and the LCSG overlap in areas of lake and shoreline management in the Northern Forest region.

State Agencies and Administrations

The work of LCSG crosses state lines; it falls in both New York and Vermont. LCSG has working relationships with both states and offers programs to communities and stakeholders throughout the Lake Champlain basin, e.g. the Green Infrastructure Collaborative with VTDEC. This alliance was founded on an already strong relationship with the agency. LCSG has worked closely with VTDEC to support the state's clean water goals through development of evaluation tools and by building a stronger connection to the scientific community. We think the shared position with VTDEC provides a model for future collaborative positions with other significant partners (see Criterion 10 — Continued High Performance).

LCSG has been a longterm partner of New York State agencies and has demonstrated leadership in development of regulation of alien species as part of New York State's invasive species control and bass tournament organization.

Local Authorities

Like many other U.S. cities, Burlington, Vermont, is managing a legacy of pollution challenges from its past, some related to industrial pollution and others to aging stormwater and sewer infrastructure. LCSG has worked with the city to educate residents about the impact of combined sewer overflows on water quality and the role of green stormwater infrastructure to capture and infiltrate runoff before it enters the city system. LCSG has provided leadership and advisory services on several green stormwater infrastructure projects and developed a system for city staff to track and evaluate residential GSI installations. Similarly, we have cultivated a relationship with South Burlington, Vermont over years of partnership on projects that serve the city's needs through application of scientific principles that improve water quality outcomes.

Since 2009, LCSG has had a long-running relationship with Plattsburgh, New York. LCSG provided advisory services regarding the effects of bass tournaments hosted by the city. The efforts ultimately led to adopting regulations that limit the number of tournaments each year. Recently, an NYSG-LCSG lecture series on underwater cultural resources and limnology was held at City Hall, along

with a special exhibit that displayed NYSG's "Great Shipwrecks of NY's 'Great' Lakes" educational panels.

Academic Institutions

LCSG significantly enhances academic and training opportunities at our host institutions, the University of Vermont and the State University of New York at Plattsburgh. We are strengthening our relationships with other institutions in the Lake Champlain Basin, including Norwich University, the Vermont Law School, and Middlebury College.

In addition to higher education, LCSG has a strong partnership with numerous K-12 institutions through the Watershed Alliance program (Criterion 5). For example, Edmunds Middle School, near the UVM campus in Burlington, has been a strong partner for many years. It reaches 300 students annually through a stream monitoring program. LCSG also supports the Poultney-Mettowee Natural Resources Conservation District to provide educational programs to schools in southern Vermont. As part of this initiative, LCSG supports an undergraduate intern from Green Mountain College.

Businesses

Bass tournament organizations such as FLW Outdoors and NY B.A.S.S. Chapter Federation assisted LCSG staff with research on dispersal and mortality of fish caught during tournaments. These events provided researchers access to thousands of live fish without using sampling gear. Results of the research led to recommendations to reduce bass mortality following catch-and-release tournaments, as noted in Criterion 6 (Advisory Services).

Realtor boards in Vermont have enthusiastically assisted LCSG in the development of continuing education workshops, as noted in Criterion 5 (Education and Training).

More than 20 marinas partner with LCSG to share clean boating education materials with recreational boaters.

Criterion 8 — Productivity

The Sea Grant Institute candidate must have demonstrated a degree of productivity (or research results, reports, students employed, service to state agencies and industry, etc.) commensurate with the duration of its Sea Grant operations and the level of funding under which it has worked.

Research Context for LCSG

In Criterion 4 (Programmed Team Approach) we noted that we look to our partners and our PAC to inform us about our research investments. In addition, we coordinate with four other closely related programs as we consider our own investments.

Lake Champlain Basin Program

We work closely with the Lake Champlain Basin Program (LCBP) to ensure that the research we fund is complementary. LCBP is a partnership of state, federal, and Canadian provincial agencies whose mission is closely related to that of LCSG. Each year the Technical Advisory Committee of LCBP solicits and funds a number of research projects parallel to the process used by LCSG. Director Bowden sits on the Technical Advisory Committee and the Steering Committee of LCBP and the Executive Director of LCBP is on the LCSG PAC. Thus there is good communication and collaboration between these organizations so that both utilize their research resources to greatest effect.

Vermont EPSCoR

Vermont is eligible for funding from the Experimental Program to Stimulate Competitive Research

(EPSCoR) sponsored by the National Science Foundation (NSF). This program is administered by the University of Vermont and funds new faculty positions, major equipment, postdoctoral fellows, graduate students, and research operating funds. Beginning eight years ago, and for the next five, the Vermont EPSCoR program is concentrating on understanding the resilience of Lake Champlain and its natural and built capital to confront future climate change. The program utilizes advanced research techniques to develop computer models that will predict future states of the Lake Champlain Basin, using downscaled projections from global and national models with agent based models that predict collective human responses to these climate changes. Given the extraordinary level of funding available from Vermont EPSCoR for basic research on Lake Champlain, in recent years LCSG decided to invest our limited resources more heavily in education and outreach as well as advisory services, often utilizing results from Vermont EPSCoR research in these activities. We also focus on topics that are less covered by the core objectives of Vermont EPSCoR.

Vermont Water Resources and Lake Studies Center and Northeastern States Research Cooperative

As noted in the introduction and in reference to Criterion 7 (Relationships), we manage LCSG in concert with the USGS-funded Vermont Water Resources and Lake Studies Center (VWRLSC) and with the USDA-funded Northeastern States Research Cooperative (NSRC). Although these programs differ from LCSG, there is substantial overlap in the missions and jurisdictions of all three programs. The overlap is particularly strong between LCSG and VWRLSC. We view this overlap as an advantage and leverage all three programs to address a broader suite of environmental and societal questions than would be possible with any one program alone.

Research Investments by the LCSG

Given the context just noted, LCSG has invested strategically in a suite of research projects (Table 3). The justifications for these projects is provided in Criterion 3 (Relevance). In addition to research supported by LCSG, we seek external funding to leverage our strategic objectives (Table 4).

Table 3. Research investments by the LCSG since achieving CAP status (2012-2016) and prior to 2012.

LCSG Funded Research 2012-18			
Years	Title	PIs	Funds
2012-14	Adapting to climate change with low impact development stormwater management in the Lake Champlain Basin	Drs. Hurley and Adair, UVM	$111,465 Federal $99,732 non-Federal
2014-16	Analysis of sediments, nutrients, and greenhouse gases associated with green stormwater infrastructure	Drs. Hurley and Adair, UVM	$103,251 Federal $71,453 non-Federal
2016-18	Identification, quantification, and distribution mapping of Lake Champlain microplastics and their potential to bioaccumulate up the food chain	Dr. Garneau, SUNY-P	$66,767 Federal $42,048 non-Federal
2016-18	Monitoring Lake Champlain to assess future climate change impacts	Dr. Leibensperger, SUNY-P	$71,279 Federal $59,696 non-Federal

Table 3. Research investments by the LCSG since achieving CAP status (2012-2016) and prior to 2012. (Cont.)

Previously Funded Research 2001-12			
Years	Title	PIs	Funds
2001-04	Diet, movement, and dispersal patterns of Double-crested Cormorants in Lake Champlain	Drs. Capen, Parrish Donovan, UVM	Information not available
2003-04	Effects of lampricide on benthic macroinvertebrates in Champlain Basin streams	Dr. Mihuc, SUNY-P	Information not available
2004-05	Feasibility study of ultrasound application for water chestnut (Trapa natans L.) management in Lake Champlain	Dr. Wu, SUNY-P	Information not available
2005-08	Use of migratory and sex pheromones to increase trapping efficiency of sea lamprey	Dr. Marsden, UVM	$106,619 Federal $55,439 non-Federal
2008-09	Indicators and standards of sustainable recreational boating on Lake Champlain	Dr. Manning, UVM	Information not available
2010-13	Strategies to increase cover cropping and improve water quality	Dr. Darby, UVM	$115,324 Federal $80,932 non-Federal
2010-13	Non-native alewife and native rainbow smelt in Lake Champlain	Dr. Parrish, UVM	$91,178 Federal $45,591 non-Federal
2010-13	Evaluation of the Champlain Canal as a current vector for invasive species	Dr. Marsden, UVM	$50,142 Federal $27,210 non-Federal

Table 4. Leveraged funding awarded to LCSG since achieving CAP status (2012 to 2016).

Years	Project	Source of funds	Funds
2011-12	Post tournament dispersal of black bass in Lake Champlain following professional catch and release tournaments.	Lake Champlain Basin Program	$67,504
2014-16	Coastal Storms: Residence resiliency programming	National Sea Grant College Program Coastal Storms Program	$80,000
2014-16	Evaluating flood hazard identification tools in two Lake Champlain Basin subwatersheds	Ohio Sea Grant Coastal Storms Program	$50,000
2015-17	Floating treatment wetlands to improve stormwater pond performance	Lake Champlain Basin Program	$26,110
2016-17	Preparing Communities to Build Resilience to Coastal Storms Through Watershed Groups	Wisconsin Sea Grant Coastal Storms Program	$5,000
2016 onward	Lake Champlain Sea Grant Educational Enrichment Fund	Private gift	$50,000

Research products from LCSG

Investments in research by LCSG have generated a number of products that enrich our programs and inform stakeholders. This includes 49 publications, reports, fact sheets, and handbooks that have been entered in the National Sea Grant Library (Appendix K). Our research also enhances the workshops and presentations that we create for our audiences. Finally, research and outreach create important undergraduate and graduate training opportunities that provide valuable experiences for the next generation of environmental researchers, educators, and stewards. Table 5 summarizes the productivity of LCSG in these areas, compared with similar data from the VWRLSC and NSRC programs. Selected outcomes from research investments are noted in Criterion 6 (Advisory Services) and will be featured during the site review.

Table 5. Summary of LCSG, VWRLSC, and NSRC metrics of productivity, 2012-16.

Role	LCSG	VWRLSC	NSRC
Federal dollars	$2,035,965	$424,865	$1,713,311
Non-federal dollars	$1,092,310	$849,730	Not required
Ph.D. students	4	5	4
M.S. students	3	7	5
Graduate assistants	2	0	5
ECO AmeriCorps members	2	0	0
Undergraduate student interns	80	20	Not available
Research projects	4	12	38
Publications (reports, fact sheets, etc)	43	12	50
Sponsored workshops	251	1	11
Public presentations	174	42	84

Criterion 9 — Support

The Sea Grant Institute candidate must have the ability to obtain matching funds from non-Federal sources, such as state legislatures, university management, state agencies, business, and industry. A diversity of matching fund sources is encouraged as a sign of program vitality and the ability to meet the Sea Grant requirement that funds for the general programs be matched with at least one non-Federal dollar for every two Federal dollars.

LCSG meets its matching obligations through a combination of institutional, state, and private sources (Table 6). Core matching funds are provided by RSENR to support the Director (Bowden), through the Robert and Genevieve Patrick Chair for Watershed Science and Planning. RSENR also provides partial support for the LCSG Extension Leader (Stepenuck) and provides business services (e.g. budget summaries, human resources) and office space and support. UVM

Extension fully supports the position of Coordinator for the Watershed Alliance (Eaton) program as well as substantial support for the Extension Leader (Stepenuck). SUNY-P provides matching support for the Aquatic Resource Specialist (Malchoff) and Associate Director (Mihuc) in New York. We expect that all research that we fund will provide 50% match. Private gifts are irregular but important in our match portfolio.

Shared positions provide an important match. Currently Director Bowden and Extension Leader Stepenuck are not fully supported by federal funding offered by NSGCP to LCSG. Funding from RSENR for responsibilities not directly related to LCSG (e.g., teaching and service) helps support both positions. More significant, however, we have developed a shared position with the Vermont Department of Environmental Conservation focused on green infrastructure for stormwater management. This 50:50 position provides an important match for the LCSG program and is a model we expect to augment in the future. We discuss the crucial role of shared positions and fellowships in Criterion 10 (Continued High Performance) as well as our justification for an LCSG Institute.

Table 6. Summary of LCSG federal and matching resources since LCSG achieved CAP status (2012-17).

Overview	2012	2013	2014	2015	2016	2017	Sum
Federal allocation	$407,000	$338,966	$430,000	$430,000	$430,000	$430,000	$2,465,966
Match obligation	$230,142	$217,167	$215,000	$215,000	$215,000	$215,000	$1,307,309
Total budget	$637,142	$556,133	$645,000	$645,000	$645,000	$645,000	$3,773,275
Expenses[1]	2012	2013	2014	2015	2016	2017	Sum
Program Management	$ 45,802	$ 94,014	$ 21,339	$ 23,207	$ 25,594	$ 26,623	$ 236,579
Communication	$ 0	$ 0	$ 28,838	$ 29,750	$ 31,878	$ 32,833	$ 123,299
Research	$ 133,659	$ 77,538	$ 95,093	$ 79,611	$ 120,928	$ 118,861	$ 625,690
Project Development	$ 35,381	$ 23,993	$ 0	$ 0	reallocated to research		$ 59,374
Outreach/Extension	$ 362,300	$360,588	$ 408,051	$422,625	$ 380,179	$ 377,633	$ 2,311,376
Climate Change	$ 60,000	$ 0	$ 30,145	$ 30,127	$ 30,064	$ 0,248	$ 180,584
Coastal Communities	$ 0	$ 0	$ 61,534	$ 59,681	$ 56,357	$ 8,802	$ 236,374
Total	$637,142	$556,133	$645,000	$645,001	$ 645,000	$645,000	$3,773,276
Match sources	2012	2013	2014	2015	2016	2017	Sum
UVM	$185,142	$ 172,167	$ 158,008	$156,285	$159,304	$157,635	$ 988,541
SUNY-P	$ 45,000	$ 45,000	$ 52,500	$ 54,075	$ 55,695	$ 57,366	$ 309,636
Others	$ 0	$ 0	$ 4,500	$ 4,635			$ 9,135
Total	$230,142	$217,167	$215,008	$214,995	$214,999	$215,001	$1,307,312

[1] Expenses line is the sum of direct Federal expenses, direct matching expenses, and associated indirect costs; i.e., the total project cost.

Criterion 10 — Continuity of High Performance

The Sea Grant Institute Candidate must demonstrate the ability to continue the pursuit of excellence and sustained performance.

This criterion includes assessment considerations that are enumerated in the accompanying text box. In our opinion we have amply demonstrated capability to perform at a high standard on each consideration. We have good reason to believe that we can continue to perform at this level — and higher — as a Sea Grant Institute. We cannot to do this without additional federal support. In closing, we provide rationale for a Lake Champlain Sea Grant Institute, respond to recommendations from our 2015 Site Review, and present a fiscal model that would support a future LCSG Institute. We conclude with an implementation strategy.

Assessment Considerations

- High performance in research, education, training, and advisory services relevant to the Lake Champlain Basin.
- Leadership in Lake Champlain Basin activities including coordinated planning and cooperative work with local, state, regional, and Federal agencies, other Sea Grant programs, and non-Sea Grant universities.
- Effective management framework and application of institutional resources to the achievement of Sea Grant objectives.
- Longterm plans for research, education, training, and extension/advisory services consistent with Sea Grant goals and objectives.
- Furtherance of the Sea Grant concept and the full development of its potential within the institution and the state.
- Adequate and stable matching financial support for the program from non-Federal sources.
- Effective systems to control quality of Sea Grant programs

Rationale for an LCSG Institute

LCSG conducts research, produces resources, and disseminates knowledge that our audiences and stakeholders value. We have a long history of involvement in issues critical to the current and future states of the environment and economy in the Lake Champlain Basin. From an original base budget of $140,000 in 1999, which supported two outreach staff, LCSG has grown to a CAP program with a base budget of $430,000 that supports 10 staff, a new research Fellow, numerous student interns, and a modest research portfolio. For reasons elaborated in the "Research Context" section of Criterion 8 (Productivity) and with the support of our PAC, we elected in recent years to invest more heavily in our capability to synthesize technical knowledge and deliver useful products to our audiences rather than in new research. This strategic decision was based on the significant investments in basic research on Lake Champlain by Vermont EPSCoR and our own capabilities to leverage research support from VWRLSC and NSRC. However, we do not think this is a prudent course for the future.

Given the level of our current base funding, we made a strategic decision in our 2018-21 Strategic Plan to develop programmatic goals for only two of the draft national focus areas: Resilient Communities and Economies (RCE) and Environmental Literacy and Workforce Development (ELWD). We made this decision on advice from staff in NSGO and with the consent of our PAC. However, we also noted in our Strategic Plan that if we are awarded a higher base funding level, we intend to expand efforts in the Healthy Coastal Ecosystems focus area (HCE). To this end we developed goals, actions, outcomes, and metrics for HCE as well as for RCE and ELWD. Details are provided in Appendix L – 2018-21 Strategic Plan. This plan was approved by NSGO Program Officer Elizabeth Rohring and Director Jonathan Pennock in April 2017.

With this as background, we are nearing a crucial point in the evolution of LCSG. As salaries, fringe

benefits, and operating costs increased over the years, our ability to support a substantive research program has eroded and we are increasingly dependent on part-time and even temporary employees to perform outreach and educational initiatives. This is not a sustainable model.

We seek Sea Grant Institute status and the potential to increase our base funding for the following reasons:

1. To rebalance our overall program by reinvigorating our research portfolio, including new research fellowships.
2. To enhance our outreach capability through new partnerships that will bring new capabilities to our audiences and stakeholders.
3. To participate more fully in the programs and governance of the regional and national Sea Grant networks.

Responses to the 2015 Site Review

The report transmitted to LCSG on the 2015 Site Review included four recommendations and one suggestion. These are addressed below:

Recommendations (Items the Program must consider)

- "As the LCSG program moves toward formal recognition as an institutional program, the relationship between the two universities should become more formalized through a written and signed MOU under the signatures of both university presidents. This should include institutional commitments and agreements with respect to funding allocations and mechanisms for fund transfer. "

We have developed a comprehensive MOU that addresses this recommendation, as well as several related governance matters not identified in this recommendation or in the 2015 Site Review. The text of the "LCSG Comprehensive MOU" is in Appendix E. This draft MOU is currently under consideration by all parties and will be implemented prior to our next omnibus award in 2018.

- "Prior to developing the institutional proposal, the SRT [Site Review Team] recommends developing/updating a strategic plan that identifies opportunities for growth, most notably in the area of research. LCSG will need to formalize infrastructure to grow, e.g. web support, communications, personnel management. The SRT saw good potential for growth as demonstrated by the enthusiasm of the partners and the concrete delivery of the messages."

We completed a new Strategic Plan earlier this year. It has been reviewed by the National Sea Grant Office and approved by letter from Director Jonathan Pennock on 14 April 2017. Our 2018-21 Strategic Plan is found in Appendix L. See the next recommendation regarding research.

- "Building a research portfolio is both challenging and essential to move forward to institutional status. Ideas gleaned from the presentations at the opportunities for future research roundtable should be mined and prioritized to develop the research plan moving forward."

As part of preparations for our 2018-21 Strategic Plan, we conducted three workshops with different groups of stakeholders and distributed a survey to our broader audience. A portion of each workshop focused on research priorities in the Lake Champlain Basin, building on the Opportunities for Future Research Roundtable that was part of the June 2015 Site Review (text box). The issues match in detail a similar list created by the Great Lakes Sea Grant Network during our regional meeting in Burlington in September 2015. These priorities also align closely with "Opportunities for Action," a research and implementation guidance document developed by the Lake Champlain Basin Program. In the section "Implementation Strategy for an LCSG Institute," below, we articulate specifically how we would move forward with this agenda.

- "LCSG should establish a more fulsome relationship with the NYSG and Northeast and Great Lakes Sea Grant programs, especially on issues that affect both regions (e.g., invasive species, canal). There is some capacity to build upon within these networks. The first pertains to shared opportunities, while the second and third are about information exchange."

Researchable Ideas

- Climate change and extreme weather events
- Coastal community resiliency
- Sustainable coastal development
- Urban stormwater runoff or green stormwater infrastructure
- Environmental literacy and workforce development
- Aquatic invasive species and biosecurity
- Marine debris and microplastics
- Harmful algal blooms
- Crude oil transport
- Phosphorus movement, sources, and sinks
- Sustainable aquaculture
- Environmental justice

Over the last two years we have developed extensive relationships with all three groups. In September 2016 staff from the Great Lakes and Hudson River Programs of New York Sea Grant met via webinar with staff from the Lake Champlain Sea Grant Program. The purpose was to share information about our outreach endeavors and to seek opportunities for future partnerships. A report of this meeting is included in our Strategic Plan in Appendix L. As noted, we have helped lead the Crude Oil Transport Initiative with NYSG and the GLSG network. Most recently we helped run the "Crude Moves" symposium in Cleveland, on 8-9 June 2017. In addition, LCSG and NYSG staff have interacted on topics ranging from preservation of historic shipwrecks to prevention of invasive species. As noted, we hosted the Great Lakes Sea Grant Network (GLSG) regional meeting in September 2015. Currently the LCSG Director (Bowden) is Chair of the GLSG Directors and the LCSG Extension Leader is Chair of the Great Lakes Sea Grant Extension Leaders. We also recently participated fully in development of the 2017 Northeast Sea Grant Network regional meeting. Extension Leader Stepenuck regularly participates in conference calls with the NESG network Extension Leaders and is currently leading its awards program.

Suggestions (Ideas the Program May Want to Consider)

- "LCSG operates very successful programs that are important and relevant to partners and stakeholders. The unique bi-state arrangement requires that staff and capacity are shared and not duplicated. It's clear that there isn't enough capacity to meet the demand that the communities have. As you add staff and capacity, consider how you will complement existing areas of effort in order to build a program area of excellence."

At various points in this Briefing Book we have suggested how and where we would build capacity. In the concluding section on "Implementation Strategy for an LCSG Institute," we propose a path forward that addresses this suggestion.

LCSG Institute Fiscal Scenarios

We fully understand that the ability of NSGCP to provide additional funding for a LCSG Institute is dependent on allocations from Congress, and we also understand that the current budget environment is challenging. That said, our visions for the future will be moderated by the funding we ultimately receive. We aspire to the base level of $1 million annually that was recommended in the NSGCP report *Policy for the Allocation of Funds, FY 2014 and Beyond*. We think that our past performance — detailed in this Briefing Book — as well as the decision metrics utilized in the Allocation Report (coastline miles and coastal population), fully justify this level of funding for an LCSG Institute.

We are confident we can identify match funding to complement the $1 million level of federal support. We expect current commitments from core LCSG partners (RSENR, UVM Extension, and SUNY-P) to continue. In addition, we receive important matching support from our Green Stormwater Infrastructure partnership with the VTDEC and the research projects that we now support. These commitments alone provide sufficient backing to match the current base level ($430,000, which requires a minimum match of $215,000, see Table 6, Criterion 9).

An LCSG Institute initially funded by $1 million would

require a total match of $500,000 or $285,000 over our current level. We would rebalance our research portfolio by investing up to $400,000 annually in a combination of research projects requiring 50% match and 50:50 LCSG Research Fellowships. This would generate at least $200,000 in matching funds. We would also create up to three 50:50 partnership staff positions similar to those with Vermont DEC. Adding salaries, fringe benefits, and overhead costs, we expect the total for each position will be $60,000 to $75,000, depending on the negotiated base salary. Shared 50:50 with a non-federal organization, we would expect each position to generate $30,000 to $35,000 in matching support, $90,000 to $105,000 for three new positions. These sources alone would more than meet the match obligations of an LCSG Institute supported by base federal funding of $1 million. In addition to these sources, a greater portion of the funds from the Patrick Chair would support the increased responsibilities of the Director. We also expect to secure additional private gifts, similar to the current $50,000 Educational Enhancement gift we recently received.

Table 7. Summary of important challenges and opportunities for selected future budget scenarios. Scenarios assume continued matching support from UVM Extension, SUNY-P, and VTDEC. (x = unable/eliminated, 0 = weak/threatened, + = strong/enabled)

Budget Component		Current Level of Funding	Partial Increase	Full Institute Funding
Administration	Director's position converted from 9- to 12-month	x	x	+
	Extension Leader position fully funded	+	+	+
	Maintain Research and Communication Coordinator	0	+	+
	Maintain part-time Fiscal Coordinator	x	0	+
Programming	Maintain Green Infrastructure Partner position1	0	+	+
	Maintain Watershed Alliance Coordinator	+	+	+
	Maintain SUNY Plattsburgh Sea Grant position	+	+	+
	Develop new long-term partnerships	x	x	+
	Maintain part-time LCSG Program Assistant	0	+	+
	Maintain part-time Lane Use Planning and Water Quality Educator	x	0	+
	Fund part-time graduate student communication assistant	x	x	+
	Fund undergraduate internships	0	+	+
Research	Fund new LCSG Fellows program	x	0	+
	Fund annual research RFP	x	x	+
Strategic	Operating budget (supplies, meetings, professional development)	0	+	+
	Matching fund availablity and leveraging capacity	0	0	+

Given uncertainty in what might be allocated to an LCSG Institute, it is difficult to plan in detail. For discussion, we outline in qualitative terms how partial and full allocations would affect major components of our program compared to the present (Table 7). In the following we conclude with specific elements of an implementation plan.

Implementation Strategy for an LCSG Institute

Immediate steps

We have timed this proposal to coincide with the current omnibus cycle ending in January 2018. Our hope is that the Site Review Team will come to a positive decision before the fall 2017 meeting of the National Sea Grant Advisory Board. In that case, we ask that NSGO provide guidance regarding a new level of base funding that we can incorporate into our omnibus proposal and budget for the 2018-21 period. The next omnibus proposal will be due in early November 2017, and if approved we would inaugurate the LCSG Institute in February 2018 and initiate our implementation strategy based on the funding we receive.

Research investments

Anticipating this proposal, we ran a request for research "expressions of interest" (EOIs) this past spring. We asked that interested parties consider our recent Strategic Plan (Appendix L) and respond with brief statements of research interest. Since no funding was promised in this request, we were pleased to receive 10 EOIs. We will feature three of these as opportunities during the Site Review. They include proposals for an innovative, pilot scale wastewater nutrient recovery and recycling system, an on-site wastewater treatment system assessment with GIS based site suitability in Lake George, and an assessment of ecosystem services provided by greenspace in Plattsburgh, NY. Pending the funding we receive, we will run a fully vetted, fast tracked RFP to identify initial projects that best fit our Strategic Plan and outreach interests.

> "For years, ECHO, Leahy Center for Lake Champlain has partnered with Lake Champlain Sea Grant to establish Vermont as a leader in building sustained, multi-sector, watershed-level initiatives that build resilience and create a culture of clean water."
>
> ~ Phelan Fretz, Executive Director, ECHO, Leahy Center for Lake Champlain

Fellowships

We propose a new LCSG Fellowship loosely modeled on the Knauss Fellowship program. Our LCSG Fellowship would provide unique early-career experiences for recent postgraduates (i.e., M.A., M.S., Ph.D. or J.D.) with an interest in water policy, watershed management, science communications, or coastal resources. Fellows would engage in research and outreach related to educational and/or legal aspects of priority issues of LCSG and its partners. These one- or two-year Fellows would receive partial support from LCSG and additional funding from major partner organizations. The partner's portion would match LCSG. Specific MOUs will be developed with each partner organization to define these relationships. For each fellowship, LCSG will establish a competitive process to select an exceptional candidate. We anticipate that several fellowships might be offered in any given year, with number and focus dependent upon partnerships that are secured. The text box provides several examples of the types of fellowships we foresee.

Outreach partnerships

Based on the success of our current staff level partnership with the VTDEC on green infrastructure for stormwater management, we anticipate creating up to three co-funded staff level positions. Over the last two years we have explored opportunities for new shared positions with potential partners and have identified exciting possibilities. Potential partnerships include a position in community engagement with ECHO at the Leahy Center for Lake Champlain, a position on environmental education and interpretation with the Lake Champlain Maritime

Fellowships

- Policy Fellow — A fellowship to focus policy questions that may include, but are not limited to: crude oil transport, floodplain management regulations and insurance, green infrastructure ordinances and codes, invasive species transport issues, and property and land use challenges as shorelines change over time. The National Sea Grant Law Center will serve as a resource to this Fellow, thus connecting to the broader Sea Grant Law Network.
- Science Communications Fellow — This fellowship would support translation of research related to significant watershed issues for both non-technical and professional audiences. Fellows may facilitate outreach that informs public audiences at museums, galleries, or other public venues. Other Fellows may focus on interpretation of technical literature for the public through popular writing, illustration, videography, or data visualization to promote knowledge and behavior change within the Basin.
- Diversity Fellow — This fellowship would focus on expanding the diversity of audiences that understand and take action to improve water quality and/or community resilience to environmental changes over time. Fellows could utilize UVM and National Sea Grant resources to carry out their work and integrate diversity efforts across the Sea Grant Network.
- Community Engineering or Landscape Design Fellow — This fellowship would focus on low impact development issues faced by communities in the Basin. The Fellow might, for example, address high priority green infrastructure projects that need maintenance or development in the partner's area of operation.
- Coastal Resilience Fellow — This fellowship would focus on coastal businesses to reduce their susceptibility and increase their resilience to extreme events and environmental change. Projects might focus on shoreline erosion, flooding, stormwater runoff, or changing on-off cycles of ice over time.

Museum, a position on public communication with the Lake Champlain Basin program, and a position on adoption of green infrastructure with the City of Burlington. We also anticipate timely growth of our Watershed Alliance program in the southern part of the lake and in New York. To accomplish this we will explore extending existing relationships with the Poultney-Mettowee Natural Resources Conservation District and SUNY-P. Finally, we anticipate development of new shared positions with current partners like UVM Extension and new partners such as The Nature Conservancy.

Priorities and Timeline

Our ability to implement this strategy is dependent on additional federal funding from NSGCP. If that support is forthcoming we would act immediately to fast track a research RFP and an LSCG Fellowship RFP. Our objective would be to rebalance our research portfolio. Depending on funding available, we would next explore establishing shared staff positions to meet our expanded strategic objectives. Two immediate areas that we think would be fruitful are a staff position to extend the reach of the Watershed Alliance program in the southern lake and New York, and partnership with ECHO on Community Engagement. Fig. 6 illustrates a potential timeline for the implementation of the LCSG Institute.

Figure 6. Potential future timeline for LCSG Institute