

STRATEGIC PLAN 2015-2020

Bigelow Laboratory for Ocean Sciences

# Table of contents

	•
	2
VISION AND MISSION STATEMENTS	5
ORGANIZATION PROFILE AND HISTORY	6
Institutional profile	6
Primary achievements of the past 40 years	8
Improvements in governance and communication	9
CRITICAL ISSUES AND STRATEGIES	10
International	10
National	10
State of Maine	12
Summary of external drivers	13
PROGRAM GOALS AND OBJECTIVES	15
Programmatic organization	15
Centers of Discovery	15
Strategic elements to promote Integrated Activities	17
MANAGEMENT GOALS AND OBJECTIVES	22
Increase in SRS support	22
Implications for managed - mode programs	23
Accountability and institutional responsibility	23
Personal performance recognition and institutional support	23
Match funding External Science Advisory Board	24
Safety and duty-of-care	24
	24
MEASURES OF SUCCESS	25
Institutional performance metrics	25
Senior Research Scientists performance metrics	25
Safe, healthy, and pleasant work environment	26
Reputation building	26
Future outlook	26

# Introduction

This strategic plan, outlining a way forward for Bigelow Laboratory for Ocean Sciences for the next five years, has been carefully considered, reviewed, and vetted by the Board of Trustees, Senior Research Scientists, Management, and staff. It has the full endorsement, commitment, and support of the Board of Trustees. We believe it provides the strategic thinking and actions needed to continue the positive momentum established in the last (2009-2014) strategic plan.

This plan serves as a roadmap for how we will continue to be successful over the next five years and meet the challenges of reduced federal support for research and increased competition for same. Its pages detail how we will address these challenges by capitalizing on our expertise, resources, cutting-edge technology, and facilities to carve out a positive, productive, and sustainable way forward.

Bigelow Laboratory for Ocean Sciences possesses all of the ingredients for a successful future as evidenced by our 40 years of contributions to the advancement of knowledge and understanding of the microbial and microscopic life of the oceans. I am confident that the Laboratory will continue its reputation as a global leader in microbial oceanography and as a preeminent ocean research and education institution, known for advancing knowledge of marine ecosystems, innovative scientific applications, and sharing knowledge to help educate and inform decision making over the next five years and beyond.

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**HERBERT PARIS** *Chairman* 

# **Executive Summary**



In 2014, Bigelow Laboratory for Ocean Sciences marked its 40th Anniversary of transformative scientific achievement. Its research has contributed significantly to what is known about marine microbes and microorganisms, how they drive and interact with ecosystem processes, and how they might respond to ongoing global and regional changes. The 40 years were marked by critical technological advances from the introduction of satellite imagery and flow cytometry for oceanographic studies to the world's first single cell genomics center, producing one scientific publication on average every ten days, and providing hands-on science training to more than 700 students and teachers in the importance of the ocean and the scientific approach to understanding the Earth.

Bigelow Laboratory has seen significant advances over the period of the last Strategic Plan (2009-2014), including the building of a new campus and laboratory facilities in East Boothbay, the establishment of an Academic Partnership with Colby College, and the hiring of eight new Senior Research Scientists (SRSs) in new areas of ocean discovery. Three Centers of Discovery were established-the Norton Ocean Microbiome<sup>1</sup> and Blue Biotechnology Center, the Ocean Biogeochemistry<sup>2</sup> and Climate Change Center, and the Center for Ocean Health-to consolidate and build on synergies of our research. The last five years also have seen dramatic changes in public awareness of the work of Bigelow Laboratory scientists and our contributions to Research, Education, and Technology Transfer. These advances provide a solid foundation for the Laboratory as we look ahead to the next five years and beyond in this new Strategic Plan.

Anchoring the Strategic Plan for 2015-2020 is our mission to investigate the microbial drivers of ocean processes through basic and applied research, education,

#### STRATEGIC ACTIONS

- Increase the involvement, visibility, and support for our Senior Research Scientists and their staffs
- Actively participate in international scientific planning and global research programs
- Strengthen technology transfer and fee-for-service applications
- Improve communication and public outreach to explain why the ocean (and microscopic life) matters

and enterprise. By 2020, Bigelow Laboratory will be a leading global ocean research and education institution, generating beneficial outcomes for society through increased knowledge of marine ecosystems, innovative scientific applications, and sharing knowledge that not only educates, but informs decision making. We aim to meet the challenges that lie ahead in a shrinking funding environment and in the changing role of science in supporting industry, policy-making, regulation, and public opinion by capitalizing on our expertise, resources, cutting-edge technology and facilities to carve out a positive, productive, and sustainable way forward.

In recognition of the critical importance of defining global research priorities and agendas, the core of our plan is to increase the involvement, visibility, and support for our SRSs, enabling them to participate in and lead cutting-edge global research programs. This effort will be complemented by strengthening technology transfer and fee-for-service applications through

<sup>1</sup> Microbiome: the ecological community of microorganisms that reside in the ocean.

<sup>2</sup> Biogeochemistry: the scientific discipline that involves the study of the chemical, physical, geological, and biological processes and reactions that govern the composition of the natural environment.

our new Office of Research Commercialization and Applications, which will emphasize the strengths of our Core Facilities<sup>3</sup>, streamline operations, and expand joint initiatives with industry sectors that include pharmaceuticals, energy, aquaculture, environmental remediation, and education. Improvements in communication and public outreach will support these efforts, helping to explain why the ocean and microbial life matter to all of society.

For each of our six Integrated Activities (Research, Education, Core Facilities, Research Commercialization and Applications, Communication, and Advancement), we define new initiatives and actions<sup>4</sup>. Briefly, to address increasing competition for research funds, we will invest in the current pool of talented SRSs by "hardening" salary support and providing incentives for them to advance institutional strategy. Over the next five years, we will hire two to three mid-career SRSs with established research portfolios to reach a total of 17 to 18 SRSs. Together, these strategies are expected to increase the return on investment for research funding at the Laboratory. We also will emphasize in-house and external collaborations to take advantage of the knowledge, expertise, and global reach of our scientists to increase knowledge with practical application.

The Education strategy will be characterized by strengthening the Colby College semester program by opening it to additional college and university participants, and by expanding our summer Research Experience for Undergraduates program by increasing both National Science Foundation and private sponsorship. We also will continue the long-running Keller BLOOM program (in its 26th year), a weeklong residential opportunity for Maine high school students, and BLOOM Educators program for their teachers. To support and expand our educational capacity, we are investigating implementation of a post-graduate program accredited through an academic partner, and we are exploring the design and cost of a new student residence with facilities for guest scientists and visitors.

Looking internally, we will maximize the investment in our six Core Facilities by capitalizing on our unique strengths and capabilities. Our Core Facilities provide research, educational, commercialization, and collaborative opportunities to Senior Research Scientists, and increase Bigelow Laboratory's reputation and competitiveness. We aim to compete with other service providers by offering unique services and expertise, advanced technologies, exceptional quality of product or analysis at competitive price points, timely delivery, excellent and informed customer relations, and coordination of multiple Core Facilities to address specific projects. We will concentrate on the efficient operation of the Core Facilities through shared financial systems and marketing. The next five years also will be marked by a major focus on national and regional industry collaborative program initiatives, and an increase in generating solution-based research outcomes that appeal to foundations and private donors. We will ensure that the products of our fundamental research and education initiatives address and solve real-world applications and problems through the new Office of Research Commercialization and Applications. Through these actions, Bigelow Laboratory will continue to help advance Maine's economy and enhance its influence in the national realm.

#### STRATEGIC RESULTS

By 2020, Bigelow Laboratory has:

- An enhanced international reputation for scientific excellence
- Expanded funding sources to allow continued discovery
- A thriving practice as an applied research partner
- Informed public opinion and policy on ocean issues
- Recognition as an important contributor to Maine and beyond

<sup>3</sup> The six Core Facilities are: The Provasoli-Guillard National Center for Marine Algae and Microbiota, Single Cell Genomics Center, Facility for Aquatic Cytometry, Bigelow Analytical Services, Seawater Suite, and High Performance Computer Cluster.

<sup>4</sup> Itemized specific goals and actions may be found in call-out boxes throughout this Strategic Plan.

Our Communications will continue to raise the reputation of the institution through intelligent and exciting conveyance of ocean science discoveries, and why these matter to society. Our communication strategy will be pervasive throughout the Laboratory, underpinning the delivery of all our primary outputs be they research, education, commercial, or reputational. The role of philanthropy ("Advancement") in supporting the mission of Bigelow Laboratory is crucial. Diminishing public funds for research, rising costs of operations, commitments to maintain advanced infrastructure, and the ability to forge new areas of research and education in the ocean sciences, all demand a coherent and careful fundraising strategy that includes both individual donors and foundations. Philanthropy is a core of our strategy, adding operational security and providing flexible funds for recruiting new Senior Research Scientists, and for taking innovative steps with industry and partner research

and academic institutions. We will recognize the individuals and organizations that have supported us through our Founders Campaign.

The strategic objectives outlined above ensure that we use our resources wisely, capitalize on our strengths, and combine the power of our expertise and innovation to forge a successful path ahead. They also have implications for governance, management, and measurement of achievement elaborated below, including establishing an External Scientific Advisory Board and new measures of personal and institutional success. Reflecting the contributions of the entire Bigelow Laboratory community, from staff to our engaged Board of Trustees, this plan harnesses the tremendous resources available to ensure a strong and vibrant Laboratory for another four decades.

# **Vision and Mission Statements**



Our vision is to be a leading global ocean research and education institution, generating beneficial outcomes for society through increased knowledge of marine ecosystems.

Our mission is to investigate the microbial drivers of ocean processes through basic and applied research, education, and enterprise.

Our planet is experiencing more rapid changes in climate, use of natural resources, and population than at any previous time in the history of civilization. With over 70 percent of the world's surface covered by the ocean, the interaction between humans and life in the ocean will be of immense significance for the 21st century. We know that the ocean plays a significant role in the physical changes the planet experiences. Less clear is the importance, feedback, and timescale between ocean biology (especially at the microscopic scale) and the physics and chemistry of the human interventions that are now dominating the natural world.

Through fundamental research into ecosystem processes, from the smallest life forms to the top of the food chain including humans, we will develop an improved understanding for predicting the environmental and societal changes that will be influenced by the ocean over the next decade. This fundamental knowledge can be applied to new techniques, applications, and procedures in the quest for sustainable economic development and business innovation. Furthermore, by engaging in an active education curriculum, informed by a cuttingedge research environment, we will attract and train the next generation of scientists, managers, and communicators to engage in addressing environmental challenges of the present and future.

In 2020, as a result of initiatives in this plan, Bigelow Laboratory will have advanced its international reputation in microbial and biogeochemical oceanography. The Laboratory will be functioning as a trusted applied research partner for large corporations to early tech start-ups. Our science will catalyze innovation in ocean policy and trusted environmental regulation. Public opinion on the state of the ocean will be informed by our science. The Laboratory will be a household institutional name in Maine and within its Legislature. Bigelow Laboratory alumni will populate all spheres of professional life, carrying with them a reputation for champions of excellence in science, useful applications of oceanographic research, sound public policy, and societal benefits.

Through fundamental research into ecosystem processes, from the smallest life forms to the top of the food chain including humans, we will develop an improved understanding for predicting the environmental and societal changes that will be influenced by the ocean over the next decade.

# **Organization Profile and History**

#### **INSTITUTIONAL PROFILE**

Bigelow Laboratory for Ocean Sciences is located in East Boothbay, Maine, USA. Founded in 1974 by the late Dr. Charles S. Yentsch, it is one of the world's leading independent oceanographic research institutions, examining the links between microbial population, ecosystem function, ocean remote sensing, and human impacts on ecological change. Research takes place throughout the global ocean, from the polar regions to the tropics, from the coast to the central ocean gyres, and from space to the deepest depths of the ocean trenches.

The Laboratory is organized as a public non-profit corporation 501(c)(3) exclusively for charitable scientific purposes including research, education, and the promotion and use of knowledge relating to ocean sciences. The primary sources of research funding are the federal granting agencies of the National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), Office of Naval Research (ONR), National Oceanic and Atmospheric Administration (NOAA), and the State of Maine Innovation and Infrastructure funds (Figure 1), supplemented by funds from providing analytical and consulting services. Funding for our Educational programs comes from institutional partnerships as well as from targeted philanthropy. Our Core Facilities are supported through fee-for-service applications open to academics, industry, and government clients, with new capacities supported by strategic investment from philanthropy. Overall, philanthropy plays an important role in maintaining the quality of the research and education programs at the Laboratory.

The Laboratory is governed by a Board of Trustees and managed by an Executive Director with an executive team, and the principal scientists (Figure 2). The principal scientists (Senior Research Scientists, or SRSs, currently 15 in number) are self-funded through research and contract awards. These Federal, state and foundation research grants support laboratory operations and administration, such that the Laboratory currently employs nearly 80 staff augmented by 15-20 interns and volunteers at any one time. Currently, the annual gross income of the Laboratory is \$12 million.





In the last Strategic Plan (2009-2014), the Laboratory outlined an ambitious plan to develop its primary infrastructure in the form of a new campus (to cope with the aging facilities at McKown Point in West Boothbay Harbor), to establish a major educational partnership with an undergraduate college, and to broaden funding opportunities to include the private and industry sectors. It is a significant tribute to the organization, and to the staff and Trustees, that the majority of the ambitious and far-reaching objectives of this strategic plan have come to fruition. The quantum improvement in research and education facilities provided a massive and timely boost for the Laboratory's strategy and implementation.

In December 2012, a new \$32 million Ocean Research and Education campus was opened on a 64-acre site situated on the shore of the Damariscotta estuary (Figure 3). This purpose-built, LEED<sup>®</sup> platinum laboratory houses the research, education, administration and support capabilities, as well as a number of important Core Facilities. These include the Provasoli-Guillard National Center for Marine Algae and Microbiota (NCMA), the Single Cell Genomics Center (SCGC), Bigelow Analytical Services (BAS), the J. J. MacIsaac Facility for Aquatic Cytometry, the High Performance Compute Cluster, and the Seawater Suite. Housing for up to eight students or visiting scientists sits at the entrance to the campus, and a library and information center is funded and operated in partnership with the Maine Department of Marine Resources. The new campus has received numerous accolades for aesthetic design, energy efficiency, and research capability<sup>5</sup>.

Colby College and Bigelow Laboratory for Ocean Sciences signed a Strategic Partnership Agreement on July 23, 2010 to create a working undergraduate curriculum program focusing on experiential learning in a research environment. This program consists of a fall semester-in-residence program for Colby students at the Laboratory, an intensive January semester of courses taught by SRSs at Colby College, and summer internships at the Laboratory for Colby students.



FIGURE 3 Bigelow Laboratory for Ocean Sciences Ocean Research and Education Campus

5 Association of General Contractors' 2013 Build New England 'Grand Honor Award'; Maine American Institute of Architects 2014 Award; Boston Society of Architects (two awards- Sustainable Design, Design); R&D Magazine 2014 Lab of the Year, Honorable Mention



### **PRIMARY ACHIEVEMENTS OF THE PAST 40 YEARS**

FIGURE 4

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2014 marked 40 years of scientific and institutional achievement. Over these decades, Bigelow Laboratory researchers have:

- pioneered the use of satellite imagery to track ocean productivity;
- mastered the art of culturing microscopic marine life:
- were the first to use flow cytometry and develop fluid imaging technology to automate the identification and enumeration of aquatic microscopic life; and
- established single cell genomic technologies to draft the genome of individual cells isolated from the environment, effectively bypassing the requirement to culture the cells first.

These skills and technologies have led to:

- the first synoptic images of the global distribution of marine phytoplankton;
- an understanding of ecological changes in the Gulf of Maine through running one of the longest times series of coastal phytoplankton productivity in the nation;
- the first long-term autonomous on-ice measurements of atmospheric chemistry year-round in the Arctic Ocean; and

• major discoveries and insights into how microorganisms thrive on and below the deep seafloor, and how nutrient limitation in the global ocean interacts with the global carbon cycle at the individual cell level through biochemical pathways.

This knowledge has resulted in the publication of 1,374 peer-reviewed publications from 1974 to 2014 (Figure 4), at the average rate of one every 10 days.

Although our strategic partnership with Colby College is relatively new, the Laboratory has a long history of educating students and scientists, focusing both on the State of Maine as well as around the world. Over these 40 years more than 700 students, from Maine high schools (through the Keller BLOOM program), colleges throughout the U.S., and post-doctoral scientists from around the world, have received scientific training at Bigelow Laboratory. In recent years, more than 50 Maine teachers have participated in courses that have given them knowledge and experiences to share with countless other students through the BLOOM Educators program. Our postdoctoral scientists are important contributing members of the Bigelow Laboratory community. They enhance the educational programs as teaching assistants and mentors, and their research contributions increase the scientific output of the Laboratory.

The Laboratory's commitment to innovation is inspiring advances in biofuels, pharmaceuticals, and natural nutritional supplements from marine resources, and advanced analytical technologies are identifying and fingerprinting the impact of human activities on the

marine environment. For example, innovation in shellfish aquaculture is allowing marine parasites to be used as models for human diseases. We are the first national laboratory to be certified by the United States Food and Drug Administration for shellfish toxin testing using chemical analytical methods. Underpinning these commercial developments is a deep commitment to protecting and conserving the global ocean by applying knowledge in a public and transparent way, and assisting policy makers and industry in making informed choices.

# IMPROVEMENTS IN GOVERNANCE AND COMMUNICATION

Bigelow Laboratory for Ocean Sciences is a researchled institution using a "soft-money" model for the support and employment of key senior scientists and their laboratory groups. Academic delivery takes place through a simple, flat organizational structure that places emphasis on academic endeavor and reputation. Essentially, the research portfolio consists of the range of science undertaken in the laboratory of each individual SRS, augmented by some key, institutionalled infrastructure initiatives. The fiduciary and legal responsibility for the Laboratory rests with a Board of Trustees, elected with term limits, working closely with the Executive Director and supported by the Corporate Secretary.

Over the time frame of the last Strategic Plan, there have been significant improvements in governance and communication. The Board of Trustees has an effective committee structure with each committee chaired by a Trustee, each with a committee charter. An independent Audit Committee oversees financial reporting activity. The SRSs also use an internal committee structure, reporting to the full SRS body on a monthly basis. Liaisons between the SRS- and Boardlevel Committees have been established to strengthen communication in both directions. Trustees and SRSs meet in person, both formally and informally every quarter. The internal executive team has been strengthened with the following positions: Director of Research and Education, Chief Advancement Officer, Director of Finance and Administration, Director of Communications, Facilities Manager, and Chief Information Officer.

Addressing the public facing image of the Laboratory has been a critical evolutionary step. Presenting the case for sound, robust and impartial science, including interpretation of the implications of this science, as distinguished from advocacy of discrete policies and actions, is the hallmark of our communication strategy. Beyond promoting the high-quality science from the Laboratory to the general public, linking the quality of our research and education programs to the philanthropic desires of our supporters and mission-driven foundations is a major thrust of our implementation and business planning cycle. Consequently, the tight coupling between good governance, communication, and advancement was a crucial aspect of our strategic implementation over the past five years, and will be a major part of the strategy outlined below.

# **Critical Issues and Strategies**



Public attention to emerging issues such as ocean acidification; Arctic sea ice melting; marine habitat destruction including sea level rise, overfishing, storm events (extreme events and tsunamis); and pollution impacts (for example, in the aftermath of the *Deepwater Horizon* event in the Gulf of Mexico, and the prospect of expanded Arctic oil and gas exploration and production) is rising on both the social and political agenda. One of the international scientific challenges is to *predict* both magnitude and frequency of these issues and events, and to *explain* why these matter both in fiscal and societal terms.

The coming decade of international level ocean science can be seen as one where collaborations are emphasized, especially between the social sciences and the earth sciences. This is vital to ensure that a wider public becomes informed leading to better decision-making. Good examples are the Future Earth program and the Blue Planet initiative, within the Group on Earth Observations program. Emphasis is placed on interconnectivity of ocean observing systems to bridge between individual process studies to improve understanding, and operational oceanography, which may lead to better forecasting and prediction.

In Europe, the next seven-year Framework Program, Horizon 2020 which began in 2014 and will run through 2020, is the largest European Union Research and Innovation program ever with over €80 billion of funding available. Notable features include the Transatlantic Alliance between Europe, USA, and Canada as part of the Galway Statement 2013<sup>6</sup>, and a major focus on "blue" growth, economy, and jobs. It is anticipated that some federal funding in the USA will be linked to these foreign programs.

Bigelow Laboratory operates on the global level, working in all of the ocean, and collaborating with scientists around the world. Some formal partnerships exist, such as POGO (Partnership for Observing the Global Ocean), while new opportunities for collaborative research and funding (such as Horizon 2020) may become available. Overall, the strategic action over the next five years is to increase the involvement, visibility, and support for our SRSs to actively participate in international level scientific planning, and to participate in global research programs. Improvements in communication and public outreach will help explain why the ocean (and microbes) matters to all of society.

#### NATIONAL

Federal funding for basic research has changed dramatically over the period of the last Strategic Plan. In particular, the investments made under the American Recovery and Reinvestment Act provided a one-time stimulus, which has been quickly followed by rising operational and infrastructure costs. For the first time, operations and management costs for the NSF Ocean Sciences Division—one of the primary federal funders of research at the Laboratory—exceed the funds available for core research, thereby reducing the competitive funding for investigator-led research projects (Figure 5).

### THE RESEARCH LANDSCAPE

- Increased public awareness of ocean related impacts
- Growing international collaboration among researchers
- Decreased federal funding
- Low level of state funding support

Business as usual is not a viable option.

The strategic action over the next five years is to increase the involvement, visibility, and support for our SRSs to actively participate in international level scientific planning, and to participate in global research programs. Improvements in communication and public outreach will help explain why the ocean (and microscopic life) matters to all of society.



Most predictions indicate level dollar funding, at best, for the next five years, which represents a drop in real dollars, and the continuing specter of discretionary budget caps. In recognition of this "funding gap," the recent National Research Council (NRC) Decadal Survey of Ocean Sciences report released on 23rd January 2015 [National Research Council, 2015] recommended a 10-20 percent reduction in infrastructure costs to make available more funding for core science over the next five years. Concurrently with this reduction in federal funding, private foundations such as the Alfred P. Sloan, Gordon and Betty Moore, Paul Allen, and Simons Foundations, and the Schmidt Ocean Institute have been increasing their involvement and support in funding basic ocean research. These grants require lower institutional overheads and are often directed at individual researchers, rather than institutions (see the section on Match Funding, below). This financial model is challenging for small, independent laboratories like Bigelow Laboratory. It is against this fiscal backdrop that a considerable degree of strategy and associated implementation plans are emanating on the national ocean research stage.

Federal and international agencies are striving to find a productive way forward that balances ocean priorities, research and data needs, and funding limitations. As previously mentioned, the National Research Council has just completed the *Decadal Survey of Ocean Sciences* commissioned by the NSF. The Office of Science and Technology Subcommittee on Ocean Science and Technology is updating its research priority plan, *Science for an Ocean Nation: Update of the Ocean Research Priorities Plan.* The National Academies study is focused on field stations and marine laboratories: *Enhancing the Value and Sustainability of Field Stations and Marine Laboratories in the 21st Century.* Lastly, an Ocean Priorities Plan and Ocean Futures task force has been established under the auspices of the Consortium for Ocean Leadership to consider needs, demands, and a unified way forward for its member organizations.

From these reports and ongoing studies some common themes are emerging: Supporting Economic Growth through development of ocean observing systems, open data to support commercial markets and industries, and advancing mapping capabilities and products. Promoting Jobs by accelerating the permitting, planning and approval process, and coastal restoration and protection. Developing a Skilled Ocean Workforce by creating a diverse, interdisciplinary skilled workforce to ensure the human capacity to manage ocean resources. Stimulating Innovation and the Future Ocean Economy by creating emerging Ocean Economic Market Sectors around climate resilience, risk management in support of maritime economic growth, improving ocean observing, forecasting, communication, and blue biotechnology-all fostering the concept of "blue jobs" and a "blue economy." There is a general demand for a national ocean economic analysis to judge potential and return on investment.

The NRC's *Decadal Survey of Ocean Sciences* report identifies eight priorities, ordered from the ocean surface through the water column to the seafloor:

- 1. What are the rates, mechanisms, impacts, and geographic variability of sea level change?
- 2. How are the coastal and estuarine ocean and their ecosystems influenced by the global hydrologic cycle, land use, and upwelling from the deep ocean?
- 3. How have ocean biogeochemical and physical processes contributed to today's climate and its variability, and how will this system change over the next century?
- 4. What is the role of biodiversity in the resilience of marine ecosystems and how will it be affected by natural and anthropogenic changes?
- 5. How different will marine food webs be at mid-century? In the next 100 years?

- 6. What are the processes that control the formation and evolution of ocean basins?
- 7. How can risk be better characterized and the ability to forecast geohazards like mega-earthquakes, tsunamis, undersea landslides, and volcanic eruptions be improved?
- 8. What is the geophysical, chemical, and biological character of the subseafloor environment and how does it affect global elemental cycles and understanding of the origin and evolution of life?

Bigelow Laboratory scientists undertake research in priority areas 2, 3, 4, 5, and 8.

The Consortium for Ocean Leadership also identifies five ocean science priorities that involve protecting lives and property in natural disasters; securing energy independence; sustaining fisheries and ocean productivity; preparing for threats to national security; and understanding a transforming Arctic. Over the next five years, these priorities will likely be reinforced by cross-agency, Non-Governmental Organizations, and academic forums.

These strategies and plans will undoubtedly influence the direction of ocean science in the United States, and therefore at the Laboratory, over the next five years.

#### STATE OF MAINE

Unfortunately, Maine's research and development expenditure as a percentage of gross domestic product is weak, ranking 45th in the nation and the lowest in the New England states (Figure 6). This translates to little available discretionary funding from the state to support federal programs that require state or private match funding. This has a disproportionate effect on small independent research institutions such as Bigelow Laboratory that might otherwise successfully compete on research quality at the national level.

Maine is currently updating its science and technology (S&T) action plan: 2010 *Science and Technology Action Plan: A Bold Approach to Stimulate Maine's Economy*. This document is authored by the Maine Innovation Economy Advisory Board, which is required by statute The amount of federal and state funding for research is significantly diminished from levels anticipated in the Laboratory's last Strategic Plan, and is not expected to recover within the next five years. Thus, "business as usual" is not a viable option.



to develop such a plan every five years starting in 2010. This S&T Plan is also a requirement for federal stimulation and action plans such as EPSCoR (Experimental Program to Stimulate Competitive Research)<sup>8</sup>. Bigelow Laboratory is participating actively in the drafting of the 2015 Plan, specifically contributing to its "Research and Innovation" sections, calling for a mechanism to provide state match for successful federal R&D proposals.

Two primary actors in the state's S&T strategy are the Maine Technology Institute (MTI, which administered the Maine Technology Asset Fund that catalyzed the construction of the East Boothbay campus, which was one of the awards of a \$50 million public bond package), and the Maine International Trade Center, which named Bigelow Laboratory as its 2012 Innovator of the Year. Both public organizations also are undergoing substantial strategic planning exercises, particularly MTI, which recently commissioned a study from Batelle to examine industry clusters to drive an "innovation ecosystem."<sup>9</sup>

#### SUMMARY OF EXTERNAL DRIVERS

Ocean science at the international and national level is expensive, and is competing with other research priorities in a crowded landscape for public discretionary funding. In nearly all developed countries, a primary reaction of government appropriation committees is to demand *relevant* science that can assist in economic competitive advantage, employment of the workforce, and development of a resilient society to overcome natural and man-made disasters. In a general sense, the funding available for basic "blue skies" research is steadily diminishing.

Opportunities to develop new research programs and win a proportionately larger percentage of the allocated funds come through the development of research consortia working internationally and nationally. Successful consortia should demonstrate excellent science, relevant outcomes, and a broad public appeal that is well justified.

<sup>8</sup> The mission of NSF EPSCoR is to assist the National Science Foundation in its statutory function "to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education." by supporting states with low GDP.

<sup>9</sup> Thirteen clusters were identified, eight of which are considered to be well-performing: Agriculture aquaculture fisheries and food production, Alternative Energy & Turbines, Biopharmaceuticals, Boatbuilding and related industries, Engineering & other Scientific/Technical Services, Environmental Services, Finance & Business Support Services, Forestry. Bigelow Laboratory's interests are in bold.

Private foundations have been significantly increasing support for ocean sciences and are considered a major new opportunity for Bigelow Laboratory. Seeking such funds requires novel engagement strategies, which the Laboratory is striving to develop. The financial model behind such awards, however, is challenging for small, independent laboratories. Foundation grants often carry incomplete institutional overheads that require a new set of financial management tools to make them sustainable from an institutional point of view. Such grants also are often directed at individual researchers delivering academic outcomes, rather than to support the work of an institution as a whole, which too, requires either a change in policy or philosophy at the institutional level. Bigelow Laboratory is, and will, continue to actively seek ways to meet these challenges to build effective and mutually beneficial partnerships with private foundations.

Most academic and non-profit research institutions are reacting to the current funding climate by increasing the breadth of their research funding sources (diversification), promoting the development of interdisciplinary consortia, investing in their core staff, and ensuring strong messaging, communication, and public outreach. In essence, the national funding picture and strategic direction is driving a consistent and ubiquitous response from institutions, making any unique and expedient solution difficult to find. It is becoming harder to stand out from the crowd when the threshold between a successful proposal and a rejected one is shrinking. Nonetheless, Bigelow Laboratory will capitalize on its strengths and assets to meet these challenges.

#### **KEY ELEMENTS OF OUR STRATEGIC PLAN**

- Continuation of research excellence
- Implementation of well-defined partnerships and collaborations
- Efficient use of resources and maximizing our infrastructure assets
- Attention to communication, commitment, accountability, and leadership
- Commitment to promote and advance success of scientists and staff

Maintaining excellence as an independent research and education institution in the face of the competitive environment outlined above. and buoyed by the successes achieved in the last five years, the Laboratory has collectively developed a new Strategic Plan to guide our course in maintaining a thriving ocean research and education institution. Our success as an independent research institution will be the result of the quality and commitment of our SRSs, research, technical, and administrative staff; the investment in infrastructure and advanced instrumentation; past experience with developing technology transfer and fee-for-service approaches to augment research; strong governance with well-connected Trustees; and a nimble approach to strategic decision making and implementation that is possible because of our size and self-governance.

# **Program Goals and Objectives**



#### **PROGRAMMATIC ORGANIZATION**

Building on the strategic planning from 2009, we will consolidate on three key research areas that we have defined as *Centers of Discovery* (Figure 7). These are: Ocean Microbiome and Blue Biotechnology, Biogeochemistry and Climate Change, and Ocean Health. The Centers of Discovery harness instrumental capability and efficient use of resources with purpose-built laboratories and Core Facilities, allowing individual SRS research programs and research applications to flourish in a collaborative environment. Current developments in microbial and genomic research offer the Laboratory the opportunity to develop fundamental new research methods in ocean systems that go beyond traditional field-to-laboratory approaches.

The three Centers of Discovery depend on six *Integrated Activities*, each with its own strategic goals. These are: Research, Education, Core Facilities, Research Commercialization and Applications, Communication, and Advancement.

#### **CENTERS OF DISCOVERY**

#### Ocean Microbiome and Blue Biotechnology

At the core of our understanding of marine microbial ecology are the cellular-, population-, and ecosystem level processes governing the "ocean microbiome." (Microbiomes are a way of looking at the entire community of microorganisms that live in the ocean so that we can understand their function and their role in global ocean processes.) Microorganisms inhabit every imaginable niche in the ocean from the sunlit waters of the tropical ocean to the deepest sub-seafloor realms to sub-freezing conditions of polar sea ice. In some cases, previously unrecognized energy sources that are not reliant on sunlight (non-photosynthetic pathways) fuel their activities. One example of this are microbes that use iron as an energy source. The research within this Center depends significantly on its Core Facilities (see below) and the vast reservoir of microbial organisms found in the natural environment and those preserved in cultures. Consideration of how this fundamental knowledge of the genomics, physiology, and biogeochemistry of microbes may be applied to industrial biotechnological applications and problems constitutes the field of Blue Biotechnology.



This Center encompasses several Core Facilities at the Laboratory including the world's first Single Cell Genomics Facility (SCGC); the Provasoli-Guillard National Center for Marine Algae and Microbiota (NCMA) containing one the world's most diverse collection of marine phytoplankton; and the J. J. MacIsaac Facility for Aquatic Cytometry, which combines flow cytometry, optical enumeration (FlowCAM® was pioneered by the Laboratory), and advanced cell-sorting. Additional capability is provided through the High Performance Compute Cluster, which is the engine room for bioinformatics development and implementation, and the Industrial Collaboration Laboratory (ICL), which facilitates hands-on analytical instrumentation for industry and regulatory agency projects managed by Bigelow Analytical Services. Currently, the ICL is housing the FDA-approved Biotoxin Testing Facility supporting the shellfish hygiene regulatory responsibility of the Maine Department of Marine Resources.

#### **Ocean Biogeochemistry and Climate Change**

The research conducted in this Center addresses questions of ocean biogeochemistry and climate change at many scales, from local to global, and from individual cells to entire ocean basins. By bringing together the research activities in ocean observing, air-sea and land-sea interactions, ocean biogeochemistry, and cellular biogeochemistry into a single, integrated space, the Center catalyzes the collaboration needed to provide scientific information on the role of microscopic marine communities in global ocean processes and climate change. Such knowledge may be used to improve ocean and environmental policy, and to allow end-toend ecosystem and elemental cycle analysis to provide a global view on the importance of the ocean.

The Bigelow Analytical Services Core Facility provides advanced instrument capability in mass spectrometry, liquid chromatography, analytical scanning electron microscopy, and radiotracer analysis to underpin the precise measurements needed to understand biogeochemical cycling. The J. J. MacIsaac Facility for Aquatic Cytometry provides a unique capability for the identification of marine phytoplankton, using at-sea laboratory capability.

#### **Ocean Health**

The Laboratory has always maintained a strong reputation in understanding the dynamics of algal blooms. Under certain conditions these may produce toxins that impact the food chain back to humans. New research in this Center focuses on the wide range of toxins being produced, including new vectors such as aerosols and the impacts of climate change on harmful algal bloom dynamics. The Center is accelerating our knowledge and understanding of the ocean's microbial systems to enable future management and stewardship of marine ecosystems, particularly through the use of predictive modeling and simulation approaches. Advanced computer models, assimilating data from agencies such as NASA, are improving the forecasting of the ecology and fisheries in the Gulf of Maine and elsewhere.

Improved tools for ecosystem management will result from better understanding of the ocean's microbial systems and their interactions. Anthropogenic effects, such as ocean acidification, are producing rapid changes from the upper layers to the bottom ocean ecosystems, from the nearshore to the open ocean. Direct human impacts, such as oil spills and the fate of other contaminants in the marine environment, particularly in the Gulf of Mexico and the Arctic Ocean, is another focus of research.

Core Facilities in support of the research objectives of this Center include the experimental Seawater Suite and the High Performance Compute Cluster, which has the data handling capacity to run ocean system models. The Seawater Suite provides a unique ability to culture large quantities of mono-specific algae under controlled environmental conditions and manipulate major ocean variables, such as the acidity of the water, to understand impacts on marine ecosystems.

#### STRATEGIC ELEMENTS TO PROMOTE INTEGRATED ACTIVITIES

For each of the six *Integrated Activities* there are essential strategic elements that translate to Management Goals and Measures of Success (see below).

#### Research

Cutting-edge ocean research has been the core of the Laboratory since its inception, and it will continue to be a key focus of our Mission, although we will expand our scope to include more focus on the priority topics and areas outlined in Critical Issues and Strategies. It is clearly evident that the ability of the Laboratory to sustain an operational model based solely on peerreviewed research grants won from federal agencies (principally the NSF) is untenable given the current funding climate, even though our scientific staff is at the top of their field and consistently has a higherthan-national-average proposal acceptance rate. This stark reality in no way reflects on our talents and abilities, but rather confronts nearly all soft-funded research institutes [see recent review by Moody's Investors Services<sup>10</sup>]. The next five years will be marked by a major focus on national and regional collaborative program initiatives, interdisciplinary approaches to assemble research teams, and an increase in generating solution-based research outcomes that appeal to foundations and private donors.

Our strategies to respond to these changes in the research funding climate are to (1) invest in the current pool of talented SRSs, with a relatively early career demographic, by "hardening" salary support; (2) increase the profile, opportunities, and career paths for postdoctoral researchers; (3) place emphasis on inter-institutional collaboration; and (4) continue to develop a culture of research excellence based on transparent reporting of achievement and recognition. These elements are elaborated on below in "Management Goals and Objectives" (p. 22).

#### ENHANCING OUR COMPETITIVE EDGE

- Invest in the current pool of talented SRSs by "hardening" salary support
- Increase profile, opportunities, and career paths for postdoctoral researchers
- Provide incentives for supporting the institutional strategies
- Emphasize inter-institutional collaboration
- Continue culture of research excellence based on transparent reporting of achievement and recognition

We will stimulate the application of knowledge gained through fundamental research to help resolve problems and provide innovative solutions through the new Office of Research Commercialization and Applications (ORCA). A comprehensive approach to the support, management, and assessment of research excellence is described in "Management Goals and Objectives" (p. 22) and "Measures of Success" (p. 25).

Over the next five years, we will seek an additional two-three mid-career SRSs with established research portfolios and collaborations to maintain a total SRS level of 17-18. We also intend to emphasize and grow the postdoctoral research component in the Laboratory, recognizing the major contributions of these early career scientists.

The next five years will be marked by a major focus on national and regional collaborative program initiatives, interdisciplinary approaches to assemble research teams, and an increase in generating solu-

There will be a major focus on national and regional collaborative program initiatives, interdisciplinary approaches to assemble research teams, and an increase in generating solution-based research outcomes that appeal to foundations and private donors. tion-based research outcomes that appeal to foundations and private donors. We have begun this process with a Strategic Inter-Institutional Partnership Agreement with the University of Mississippi, and a Research Agreement with the Yale University School of Medicine, and are looking to expand this area of activity over the next five years. In essence, we wish to stimulate the application of knowledge gained through fundamental research to help resolve problems and provide innovative solutions, which are under the strategic review of the Office of Research Commercialization and Applications described below.

#### Education

The Laboratory's education strategy is focused on undergraduates, with two principal components: the Academic Partnership Agreement with Colby College and the NSF-sponsored Research Experience for Undergraduates (REU) program. The Colby College partnership, which was established in 2010 and renewed in 2013, includes two JanPlan courses delivered on the Colby campus by SRSs, a fall semester inresidence program in oceanography based at the Laboratory taught by SRSs and postdocs (as teaching assistants), and numerous intern and honors thesis project opportunities in the summer as part of the REU experience and throughout the academic year. SRSs are granted Research Scientist status by Colby College, and are eligible for shared use resources such as library and purchasing agreements. These major undergraduate activities are a direct product of the 2009-2014 Strategic Plan, representing significant progress in the pedagogical objectives of the Laboratory.

A long-standing educational focus of the Laboratory supports "STEM" (Science, Technology, Engineering and Mathematics) activity in the State of Maine through the Keller BLOOM program for high school students (now in its 26th year) and the BLOOM Educators Program for high school teachers (now in its sixth year). These weeklong programs are hallmarks of the Laboratory's education portfolio, and provide critical training experience for our postdoctoral researchers.

Over the next five years we intend to promote our teaching activity by (1) increasing the participation of SRSs and postdocs (as teaching assistants) in the curriculum; (2) increasing the Colby College student par-

ticipation in the semester program, and potentially, to offer the course to additional college and university participants with credit sharing arrangements through Colby College and on a fee-paying basis; (3) strengthening the REU program by increasing the NSF-sponsorship from eight places to ten; (4) developing the REU program to encompass community colleges to bring in more diverse students; (5) continuing the excellence of the Keller BLOOM program and maintaining the BLOOM Educators program through donor support; and (6) exploring additional professional short courses, such as the Algal Culturing Techniques Course run by the NCMA on an annual basis, and courses in flow cytometry and marine biogeochemistry. All these initiatives require commitment of SRS, teaching assistant, and support staff time, and require cost-recovery of institutional overhead on salaries to avoid the "opportunity cost" of maintaining a vibrant and important education program without loss of institutional overhead funds vital to support the sustainability of the Laboratory.

## **KEY EDUCATION GOALS**

- Increase SRS and postdoc (as teaching assistants) participation in the curriculum
- Increase Colby College student participation in the semester program, and involvement with other colleges
- Strengthen the REU program by increasing NSF-sponsorship and funding from other sources
- Expand the REU program to encompass community colleges and minorities
- Continue Keller BLOOM and BLOOM Educators programs
- Explore additional professional short courses
- Create a graduate degree program in collaboration with an external degree-awarding institution
- Explore construction of a new residential facility for students and scientific visitors

Two new components of the education strategy are envisaged over the next five-year period. First, the Laboratory is actively engaging universities with postgraduate degree awarding powers to examine the possibility of Masters or PhD-level students being based at the Laboratory, with faculty mentors from both our SRSs and the degree-awarding university. This exploration process will address financial, reputational, quality, and commitment challenges that would require resolution prior to implementing a partnership agreement. Research at the Laboratory would benefit from the longer-term engagement of graduate level students, and SRSs would have additional opportunities to engage in education. Second, the Laboratory is commissioning a feasibility study for architectural and cost estimates for a student and visiting-scientist residence on the East Boothbay campus. Such a residence may be in the region of 32 beds with another five visitor's suites, with an approximate capital and project cost of \$5.5 million. Master planning approval, and environmental and town permitting, is already in place for the residence. Increasing housing space on campus for students and visiting researchers would enable larger educational programs, without associated administrative burdens for finding appropriate housing in the neighborhood, while recouping the expenses.

#### **Core Facilities**

Our six Core Facilities represent major investment by the Laboratory in the skills, infrastructure, and instrumentation necessary to deliver world-class science. These facilities benefit our own researchers, as well as our external collaborators and users. Significant additional cost-effective savings and revenue generation is achievable through coordinated management, attention to project delivery, investment in staff training, and appropriate incentives. All revenue generated from these services flows back to support the primary research, education, and enterprise mission of the Laboratory.

The Core Facilities will operate with individual business plans, recognizing their different origins, markets and operational constraints. SRSs and Research Scientists who manage the Core Facilities will be recognized through salary support and delegated authority to drive improvements and excellence in delivery to both internal and external customers. The NCMA and SCGC also operate with the advice of an external Scientific Advisory Board.

#### **CORE FACILITY GOALS**

Maximizing the Laboratory's investment in expensive analytical and experimental facilities will be achieved through efficient operation of the Core Facilities, including shared marketing, financial systems, and progress reporting.

Maximizing the Laboratory's investment in expensive analytical and experimental facilities is achieved through efficient operation of the Core Facilities, including shared marketing, financial systems, and progress reporting. The role of Communications (through marketing), and Advancement (through funds to support new instrument purchases) provide the foundation that allows the Core Facilities to offer excellence in Research, Education, and Commercialization (external customers).

In addition to the quality of the research know-how that is the foundation of the operation of the Core Facilities, we aim to compete with other similar service providers through our unique selling points (USPs): (1) quality of product or analysis; (2) timely delivery to the customer; (3) excellent customer relations both internally and externally; (4) ability to align advanced technologies to address a customer's needs; and (5) the coordination of several of our Core Facilities to address a customer's project. With attention to these five USPs, we believe that our price point, although high due to location and relatively low volumes of sales/projects, will be extremely advantageous to the range of clients with whom we engage.

## ORCA: Office of Research Commercialization and Applications

Ensuring that the products of our fundamental research and education initiatives address and solve real world applications and problems is the strategic objective of ORCA. The 2013-2017 Business Plan envisaged a Corporate Alliances and Technology Transfer program, with additional research projects commissioned by private sector industry. Although substantial progress towards improving the professional management of intellectual property (IP) and contractual engagement with private entities has been achieved, this program did not realize its full potential. A simple SWOT (strengths, weaknesses, opportunities, and threats) analysis pointed to (1) challenges in understanding, knowledge, and confidence of our SRSs to engage with industry; (2) physical location of the Laboratory with respect to major commercial centers; (3) lack of clarity around our unique selling proposition and coordinated marketing; and (4) uncertain "reward" mechanisms, both in academic and financial terms.

Reorienting the technology transfer strategy within ORCA will overcome these obstacles with the following objectives: (1) emphasize the strength of our Core Facilities; (2) streamline IP and contractual procedures by running these through the Executive Director's office and dedicated external legal counsel; (3) emphasize the personal chemistry and engagement between SRSs and their industry counterpart so that projects can be developed jointly; (4) improve marketing and communications; (5) broaden the industry sectors for engagement to now include pharmaceuticals, energy, aquaculture, environmental remediation, and education; (6) allocate internal funds through a bidding process to allow proof-of-concept data and information to be collected; and (7) address incentive mechanisms through transparent allocation of net proceeds from ORCA projects.

The beginning stage of the ORCA program will be managed by the Executive Director with Core Facility Directors and SRSs and supported by a Business Development and Marketing assistant. As the program grows, it may be necessary to develop a new director position to manage this program.

## **ORCA GOALS**

ORCA will be a mechanism by which matches are made between industry needs and the Laboratory's expertise and capabilities. ORCA will achieve success by emphasizing the strength of our Core Facilities, streamlining operations, ensuring funding and resources are available to explore opportunities, and improving communications and marketing.

#### **COMMUNICATION GOALS**

Bigelow Laboratory's objective is to convey efficient, intelligent, and exciting communication of ocean sciences discoveries, and why these matter to society.

#### Communication

External communication to the public, industry, and decision makers is a vital aspect of the mission of the Laboratory, to clarify what we do and why it matters. Although recent progress has been made, the Laboratory has long suffered from being a "well-kept secret" in Maine with a rather enigmatic mission that is opaque to many.

To broaden our reach in communicating to the public, this Strategic Plan envisions a communication strategy that is pervasive throughout the Laboratory, and serves as a foundation for the delivery of all our primary outputs be they research, education, commercial, or reputational. The strategy involves traditional (annual report, newsletter, press releases), current (social media), and personal (public appearances, art meets science, community building) outreach efforts to achieve higher visibility and an informed public. Attention is placed on a web-based strategy linking to social media alerts, backed up by high quality print publications. Building a trusted network of reporters in the public press to carry our science stories is key. Opportunities exist to use interns and other students to develop these media while helping them to learn the skills and challenges associated with public communication of the sciences. Our efforts will also extend to improving industry awareness of the Laboratory and its facilities through targeted marketing, white papers in trade journals, and an increased presence at trade shows and other gatherings where targeted industries are present.

Bigelow Laboratory is dedicated to communicating its scientific findings and their relevancy. Our primary objective is to convey efficient, intelligent, and exciting communication of ocean sciences discoveries, and why these matter to society. Presenting sound science to aid in decision-making by public bodies is vital; taking a position for an individual interest group is not within our mission.

The past few years have been characterized by a diminishing expertise of our civic leaders in understanding scientific concepts, particularly on long-term issues that will have societal impact. To convey the importance of our scientific outcomes to decision makers and aid in informed decision making, the Laboratory will increase its collective effort in communicating with policy makers, in engaging with the allocation of public resources to support our science against identified and measurable criteria, and to ensure the next generations remain enthused and energized to pursue STEM careers.

#### Advancement

The role of philanthropy ("Advancement") in supporting the mission of Bigelow Laboratory is crucial. Diminishing public funds for research, rising costs of utilities and salaries, commitments to maintain advanced infrastructure, and the ability to forge new areas of research and education in the ocean sciences, all demand a coherent and careful fundraising strategy.

The Laboratory is "non-traditional" in terms of fundraising for capital investment. The huge, and most welcome, public investment (\$18.5 million) in our \$32 million campus ensured that a long-term strategy to repay our \$13.5 million mortgage will be a central part of current and future business plans. Science needs will not diminish as we seek funds for bringing new SRSs to the Laboratory (start-up funds) or new items of equipment as we strive to remain at the cutting edge of global ocean microbial ecology and why this matters for education and society. Currently, no major endowment exists.

Philanthropy is therefore at the heart of our strategy, both for operational security, delivering excellence in our research and education programs, and ensuring the product of our endeavor reaches the public and

#### ADVANCEMENT GOALS

- Support the operational business plan through "unrestricted" giving
- Maintain investment in our laboratory instrumentation, directly or with match funding
- Support our education programs including the student and visiting scientist residence
- Create competitive start-up packages to attract world-class scientists
- Forge partnerships with other organizations in Maine and elsewhere
- Demonstrate that unique, excellent, and relevant ocean science takes place in Maine

decision makers. By creating an excellent development team, closely aligned with the Board of Trustees, we will use philanthropy to propel the mission of the Laboratory.

Over the coming years, we will seek to engage with individuals and foundations of stature, both in Maine and beyond. We will develop this engagement into personal interactions, demonstrating the uniqueness and importance of our ocean science. Through our Founders Campaign, we recognize those individuals and organizations without whose support, the Laboratory could not have been able to realize its long-held ambition to have its own laboratory and campus. Individuals and organizations that support the mission of Bigelow Laboratory will have the opportunity to naming rights assigned to various elements of our worldclass campus.

# **Management Goals and Objectives**

To deliver the range of strategic goals outlined above, a number of management actions will be undertaken. These are briefly described below, and will be designed and implemented through the governance structure of the Board of Trustees, executive office, and the SRS Committee and its sub-committees.

### **INCREASE IN SRS SUPPORT**

Until July 2014, SRSs received six weeks of salary support per annum to allow for the time to write proposals, serve on internal and external committees, and provide other institutional duties. In recognition of the growing demand on their time for such activities, this "PI Admin" support has been raised to eight weeks per annum. In parallel, internal governance committees have been strengthened with individual chairs taking responsibility for each committee's charter and operation. The proposal submission process is now well defined with commitments to internal peer review and sufficient time for financial and quality checking before submission.

A new category of SRS support has been introduced known as the PI Institutional Effort (PIIE) program. This will provide SRSs and the Laboratory executive management with additional resources to accomplish institutional projects and address strategic activities. PIIE support has been budgeted at four weeks per SRS, with those SRSs who receive institutional support for other activities (e.g., Director of Research and Education, core directors, and SRSs on start-up funds within their first two years at Bigelow) eligible for reduced PIIE support. An additional total of eight weeks of PIIE support is available for distribution by the Executive Director and Director of Research and Education (ED/DRE), as appropriate. Examples of PIIE activity might include involvement in establishing national science priorities, as recently happened at the Laboratory in helping to plan the future for ocean biogeochemical research under the auspices of an NSF-sponsored workshop, and state-level initiatives such as the creation of the Algal Cluster Initiative, which is bringing together macro- and micro-algae experts in academia and industry.

PIIE is intended to empower both SRSs and Laboratory management to pursue financially and/or strategically-beneficial activities. The ED/DRE may approach SRSs throughout the year about engaging in an activity that could be supported with PIIE time. Additionally, SRSs are invited to propose PIIE activities. A list of approved PIIE activities (one-two sentence description) will be provided to all SRSs at the end of each quarter. The DRE will maintain a record of PIIE support approved during the year.

Bigelow Laboratory will explore the possibility of a temporary industry placement, both for industry employees to work at the Laboratory for periods in excess of a month, and for our SRSs to gain experience in industry or government agencies.

This increase in investment in SRSs will not only benefit the Laboratory through additional time to meet strategic objectives, but it will also enhance the retention capability of the institution toward our talented scientific team.

An increase in investment in our Senior Research Scientists will not only benefit the Laboratory through additional time to meet strategic objectives, but it will also enhance the retention capability of the institution toward our talented scientific staff.

#### **IMPLICATIONS FOR MANAGED - MODE PROGRAMS**

To respond effectively and in a timely fashion, the ED and DRE will actively initiate collective responses to regional, national, and international research, education, and ORCA programs. The investment in PIIE support will provide the impetus and match funding necessary for such participation. SRSs will be encouraged to identify and pro-actively engage in developing such opportunities, through such mechanisms as planning workshops or serving on national committees.

In general, it is expected that an increase in managedmode research programs, with SRSs operating in collaboration both internally and externally, will take place. Project management skills will be required for effective delivery. Opportunities will be provided for increased professional skills development and training.

## ACCOUNTABILITY AND INSTITUTIONAL RESPONSIBILITY

Over the course of this Strategic Plan, there will be a progressive and earnest responsibility of all staff toward the institutional goals and objectives identified in this plan. The model of Bigelow Laboratory of individual entrepreneurial scientific endeavor will evolve more into a cooperative, where defined roles and responsibilities will be held accountable through transparent performance measures and increased intrainstitutional visibility. It is recognized that such a transformation will not take place instantly. With more collective responsibility and focus on measurable outcomes, the *Critical Issues* identified above will maintain the flexibility, independence, and reputation of the Laboratory.

In return for increased institutional support, each SRS has given a personal commitment to place the institutional needs and strategy on an equal basis with his/ her personal objectives and goals, and to communicate effectively and fairly with his/her colleagues and the executive management. The Laboratory will continue to invest in the tools and personnel skills to deliver excellence in reporting and decision making to provide needed support to allow this to happen. To achieve collective cooperation, the Trustees, executive management, and SRSs have agreed to increased dialogue and cross-representation at the committee level. Regular laboratory-wide meetings will be held to apprise all of progress in moving toward success in increasing funding and expanding business opportunities and seeking input on how tasks might be accomplished differently and better. A new *Implementation Plan* will be prepared to accompany revisions to the current *Business Plan*, identifying opportunities, targets and resources necessary to deliver the primary *Integrated Activities*. We believe that by engaging all in the execution of this Strategic Plan that it can and will be realized.

# PERSONAL PERFORMANCE RECOGNITION AND INSTITUTIONAL SUPPORT

Over the next five years, the Laboratory will develop improvements to personal and institutional reporting in line with Measures of Success outlined below. There is a clear awareness that improvements in performance should attract clear and unambiguous recognition. Therefore, the following "benchmarking" exercises are being undertaken to ensure transparent and equitable salary parity for all positions across the Laboratory. (1) All positions have been subject to the State Job Classification process, a clarification of exempt/non-exempt status, and an up-to-date job description; (2) All research, technical and administration positions are being benchmarked, using their job descriptions, to the Association of Independent Research Institutes (AIRI) annual compensation analysis taking into account our geography and size and the Maine Association of Non-Profits; (3) All SRS salaries are being considered for accelerated salary "steps" in recognition of performance criteria currently being established, and the salary profile is being benchmarked to other academic and AIRI institutions operating in the environmental research space; (4) The senior executive management salaries (Executive Director, Chief Advancement Officer, Director of Finance and Administration, and Director of Research and Education) will be determined by a Compensation Sub-Committee of the Governance Committee of the Board of Trustees, with the Chair of the Board.

## **MATCH FUNDING**

Over the past few years there has been a significant rise in funding opportunities from the foundation sector, and in some cases from smaller public federal and state agencies, where full funding for institutional overheads is not provided. Many will provide for direct costs associated with research projects, but only limited reimbursement for indirect costs, which are those not directly attributable to a project but cover administrative expenses such as rent, utilities, support staff, and other expenses needed to conduct research work. Figuring out ways to cover non-reimbursed indirect costs is a significant challenge for small independent institutions like Bigelow Laboratory.

To advance our ability to compete for these new funding opportunities, it is vital that the SRSs cover the full expenses of their laboratory research operations by careful examination of their budgets, and to maximize usage of our excellent Core Facilities when possible. In addition, other non-research projects and programs will continue to contribute to increasing the indirect cost pool.

Bigelow Laboratory is explicitly investing in its Core Facilities to maximize its ability to bid for funding from foundations and smaller agencies. This investment will contribute to reducing our indirect costs by providing additional income to the Laboratory. In return, the SRSs are developing research and financial plans that *minimize* the financial impact to the Laboratory by covering all associated costs of their research and operations.

#### EXTERNAL SCIENCE ADVISORY BOARD

Over the coming year, an External Science Advisory Board (ESAB) will be assembled comprising no more than five individuals who could offer an un-biased and strategic perspective on the progress of Bigelow Laboratory, as a whole. This would not be an in depth analysis of each SRS's research program, but rather "management and performance" evaluation and gap analysis that would inform the SRSs, executive management, and Trustees of whether our progress is appropriate. The ESAB would be able to comment on how well the Laboratory has positioned itself in terms of its breadth of expertise, and whether we have set ourselves up to stay at the front of new funding opportunities and research initiatives. It would have the added advantage of increasing institutional visibility at a time of intensive national competition.

## SAFETY AND DUTY-OF-CARE

Bigelow Laboratory continues to emphasize the vital attention to safety, and the importance of understanding a duty-of-care to all employees, particularly to the students who are in our organization. Over the past year, agreements with Colby College approving our institutional approach have been signed. All staff will continue training and attention to best practice in all areas of personnel management and interaction. The safety of all employees, students, and visitors is of paramount importance, and all procedures, equipment, and responsibilities are reviewed regularly by the Safety Committee. Continued emphasis will be placed on SRSs, as senior managers, to understand the important and responsible role they play in ensuring a healthy, safe, and pleasant working environment.

# **Measures of Success**



To evaluate the progress of the Strategic Plan, and through accompanying Implementation and Business Plans, a number of key measures of success are proposed. The following measures will be collected on an annual basis, often in parallel with the annual appraisal for individuals, or the Annual Report for the Laboratory. The personal performance metrics for Senior Research Scientists will be available to the full SRS and Board of Trustees committees, and the institutional performance metrics will be available publicly.

## INSTITUTIONAL PERFORMANCE METRICS

#### Academic

Total publications, ratio of high impact publications, and pick up in popular media

SRS retention, percentage of external funding support, professional development

## Financial

Financial performance against approved budget

### **Balance sheet**

Cost efficiency (measured by a variety of standard institutional metrics)

## **Advancement**

Net philanthropy, giving, and planned giving

Lowering institutional indirect rate / lowering percentage of philanthropy for indirect support

#### Educational

Partnerships in collaborative programs

Student throughput

Environmental commitment

Reduction in carbon footprint, and reduction of waste streams, especially plastic

## Commercialization

Number of industry partners, patents, royalty and licensing agreements

Net revenue and project delivery

#### Outreach

Public visibility through website and social media recognition

Pick up of press releases in state and national media

Visitors from academia, industry, and the public

Awards

# SENIOR RESEARCH SCIENTISTS PERFORMANCE METRICS

#### Scholarship

H-index trend over period

Peer-reviewed publications over period

Invited talks over period

Academic awards or keynotes at national/ international meetings over period

Conference/meeting presentations

Participation in national/international workshops in one's field

#### Grantsmanship

Total direct award value over period

Total indirect revenue over period

ORCA-related projects over period

Diversity of funding sources

Number of proposals submitted vs. funded

Number of proposals submitted as PI or co-PI

#### **Education and mentoring**

Undergraduate student mentoring

Involvement in course teaching, including international/national/ local workshops, training, professional development courses

Graduate student mentoring

Supervisees (including staff) and student evaluations

Presentation at postdoc training seminar

Non-Bigelow Laboratory public outreach

#### Internal engagement

Committee chair service over period

Committee service over period

Advancement office service

Communications office service (e.g., Café Scientifique, outreach, etc.)

Laboratory special projects (MRI, facility improvements, etc.)

Innovation over past period

In the case of Core Directors and Director of Research and Education, their performance as such will be evaluated separately. Expectation values will be pro-rated by their time commitment as SRSs.

#### External engagement

Government/Research scientific steering board/ advisory panels

Society or professional board/committee

Scientific meetings/conferences

National or international science /implementation plan or science scoping for field program

Journal editorial position

Reviewing activity

Grant review panels

### SAFE, HEALTHY, AND PLEASANT WORK ENVIRONMENT

Bigelow Laboratory is totally committed to its employees, students, and visitors. To ensure performance in this area, we will record hiring procedures, equal opportunities for employment, staff training, sick days, staff grievances, and place great emphasis on regular staff-wide communication, social events and feedback upwards and downwards to executive management and Trustees.

#### **REPUTATION BUILDING**

Although this area of performance is very difficult to evaluate objectively, we will monitor and report on: community relations, public interest, media coverage, institutional visits from academia and the private sector, support to other non-profit programs, general awareness of our reputation within Maine, nationally and internationally.

## **FUTURE OUTLOOK**

The past five years have seen dramatic physical and relationship developments for Bigelow Laboratory for Ocean Sciences. These developments, and the hiring of new, world-class scientists, have created a solid platform on which to weather the impending funding challenges and maintain the flexibility, independence, and reputation of the Laboratory. Careful planning, with a clear focus on primary objectives, using the tremendous resources at our disposal will ensure a strong and vibrant Laboratory for another four decades of discovery and beyond.

# Resources

# URLS FOR ORGANIZATIONS AND DOCUMENTS LISTED IN STRATEGIC PLAN

### **Organizations**

Blue Planet initiative, www.oceansandsociety.org

Future Earth program, www.futureearth.org

Horizon 2020, www.bit.ly/1FTLpfC

POGO Partnership for Observing the Global Ocean, www.ocean-partners.org

#### **Ocean Planning Documents**

Consortium for Ocean Leadership: *The Ocean Priorities Plan and Ocean Futures Task Force*, www.bit.ly/1F3ZtCC

Consortium for Ocean Leadership: *Five Ocean Science Priorities*, www.bit.ly/1F3ZBlD

National Academies: *Enhancing the Value and Sustainability of Field Stations and Marine Laboratories in the 21st Century*, www.bit.ly/1F3ZG8X

National Research Council (2015), *Sea Change:* 2015-2025 *Decadal Survey of Ocean Sciences*, Natl. Acad. Press, Washington, D. C., www.bit.ly/1F3ZKWb

Office of Science and Technology Subcommittee on Ocean Science and Technology: *Science for an Ocean Nation: Update of the Ocean Research Priorities Plan*, www.bit.ly/1F3ZMod

#### Other Documents

Maine Science and Technology Action Plan: 2010 Science and Technology Action Plan: A Bold Approach to Stimulate Maine's Economy, www.bit.ly/1F3ZSFd

Maine Technology Institute: *Innovation Ecosystem*, www.bit.ly/1F3ZUwK





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