

University of Maine System
Program Integration
Round Two

Biology

Below please find a summary of the key points derived by the UMS Chief Academic Officers from the report provided by the **Biology** program integration team. The team's full report follows the CAOs' summary and recommendation.

UMS Chief Academic Officers' Summary and Recommendations

Biology

Faculty and support staff representing all seven UMS campuses met in person on two occasions and conducted multiple meetings using Google hangout and email to collaboratively create their report and recommendations.

The report is careful to recognize the diversity of Biology programs within the UMS. It is also careful to address the specific charges for which the team was responsible.

The team's report notes that Biology is one of the few programs present on all seven UMS campuses because it is so integral to general education, serves a variety of majors, and represents a significant portion of the coursework required by the intended majors of 47% of high school graduates. In addition to serving diverse curricular needs, the team's report notes that the Biology programs all have extensive research and service programs that connect to local, regional, and national stakeholders across private, non-profit and public sectors. Given the breadth, depth, and geographic footprint of UMS Biology programs, the team's report identifies several actions intended to enhance academic quality, increase enrollment and address financial sustainability. The team's report expresses their agreement with the idea that by acting in a more coordinated way, rather than as components of seven distinct campuses, the UMS Biology programs will be better positioned to utilize resources effectively and to attract greater numbers of students and increased levels of funding.

Specific recommendations emerging from the Biology Program Integration team and endorsed by the CAO Council include the following:

Academic Quality

- Identify and develop ways of increasing the use of high impact curricular, co-curricular and career-related experiences and practices
(Timeline: Spring 2017)
- Explore the development of a website that would promote the curricular and co-curricular opportunities available at all seven campuses
(Timeline: Fall 2017)
- Establish an annual UMS-wide Biology symposium to facilitate interaction of undergraduates and graduate students, faculty, and employers, as well as to provide workshops to advance the recommendations outlined in this document

(Timeline: AY 2016-17)

Enrollment

- Create a plan and timeline for aligning course numbers and outcomes as appropriate, needed, and feasible. (The team believes that in many cases an alignment of 100 and 200 level course objectives is largely present and common numbering may not be needed)
(Timeline: Fall 2017)
- Create an accurate summary of all course equivalencies for general education and upper division courses
(Timeline: Spring 2017)
- Create a plan for user-friendly access to transfer equivalencies for prospective and current students, as well as for faculty and staff
(Timeline: Fall 2017)
- Identify obstacles to enrolling in courses at campuses other than a student's home campus
(Timeline: Spring 2017)
- Identify sub-disciplines within UMS Biology programs, i.e. Neurobiology, that could become multi-campus collaborative concentrations
(Timeline: Spring 2017)
- Develop suggestions or recommendations of IT colleagues that would ease the use of distance education across UMS campuses and centers
(Timeline: Fall 2017)

Financial Sustainability

- Develop a plan for coordinating and advertizing a select set of upper-level courses in which students from multiple UMS campuses could enroll
(Timeline: Fall 2017)
- Develop a plan for a graduate teaching exchange designed to 1) enrich the graduate student's teaching experience; 2) connect undergraduate and graduate students and programs; and 3) provide cost-savings to the campus receiving the graduate student instructors
(Timeline: Fall 2017)
- Explore the possibility of UMS-wide Biology research collaborations with a view to attracting NSF, NIH and other funding
(Timeline: Spring 2017)

- Explore the possibility of developing a more strategic, adaptive and time-responsive process for introducing new curricula to meet changing needs in the workforce and in the Biological sciences
(Timeline: Fall 2017)

1. Cover Sheet

University of Maine System
Biology Program Integration Report
March 1, 2016

2. Team Membership

Campus	Team Members	Title
UC	Jim Bradley	Student Services Coordinator
UM	John Mascetta	Advising and Student Services Center
UM	Andrei Alyokhin	Director, School of Biology & Ecology
UM	Mary Tyler	Professor of Zoology
UMA	Susan Baker	Associate Professor of Science
UMF	Dan Buckley	Professor Biology
UMF	Ron Butler	Professor Biology
UMFK	Peter Nelson	Assistant Professor Biology
UMFK	Stephen Hansen	Associate Professor of Biology
UMM	Sherrie Sprangers	Professor of Biology
UMM	Ellen Hostert	Professor of Biology
UMM	Eric Jones	Assistant Professor of Botany
UMPI	Jason Johnston	Associate Professor Wildlife Ecology, team leader
UMPI	Scott Dobrin	Assistant Professor of Biology
USM	Dave Champlin	Associate Professor of Biology
USM	Doug Currie	Associate Professor of Biology

3. Executive Summary

Faculty and support staff from all seven UMS campuses met on two occasions and conducted multiple exchanges by Google hangout and email to create this report collaboratively. The overall experience of collaborating across campuses was collegial, and we carefully addressed the 4 main charges. Biology is one of the few programs that is on all seven UMS campuses because it is so integral to the general education, serves a variety of other majors, and represents a significant portion of the coursework for 47% of high school graduates' stated college major. In addition to serving these many curricular needs the campus' biology programs all have extensive research and service programs that connect to local, regional, and national stakeholders and collaborators across private, non-profit and public sectors. Given the breadth, depth, and geographic extent of UMS biology resources, there are a number of actions that would increase quality, enrollment, and financial productivity. This group agrees with the spirit of the program integration process, i.e. that by acting more like a system, rather than seven distinct campuses, we can better utilize our resources to attract students and funding.

In order to increase actual (or perceived) quality of academic programs we recommend the following: 1) a website that features the collective curricula and opportunities for all seven campuses, 2) a statewide symposium that would facilitate the interaction of undergraduates, graduate students, faculty, and potential employers, 3) further use of high impact teaching practices, and 4) deliberate career pathways and experiences.

To increase access and enrollment: 1) the committee does not think a substantial alignment of 100- and 200-level course numbers or objectives is necessary, as this is already largely established. A more accurate summary of all the equivalencies will be needed, and there should be a careful evaluation of equivalencies where these are not already established (this is likely a small number of courses), 2) improved access to transfer equivalencies, for prospective and current students as well as faculty and staff, is needed, 3) easier enrollment in courses different from a student's home campus, 4) identify subdisciplines, e.g. neurobiology, within the UMS that would target specific multi-campus collaborative concentrations, and 5) provide necessary IT infrastructure at both campuses and centers to increase ease of distance education.

To increase productivity and financial sustainability we recommend: 1) publishing and coordinating on a select basis upper level courses in which students could enroll at a different UMS campus, 2) develop a graduate teaching exchange to enrich the graduate teaching experience and connect undergraduate to graduate students and programs, 3) develop UMS-wide biology research collaborations that may attract NSF, NIH or other funding, 4) develop a system-wide marketing, recruiting, and admissions strategy, and 5) develop more strategic, adaptive and time-responsive processes to provide college curricula to changing workforce needs in the biological sciences.

The implementation needs for these recommendations will not require significant investment in biology programs. There may be some cost savings associated with coordinating our course offerings, and perhaps a slight revenue if grants are successful; however, we recognize these would be small. We think by being strategic in relation to workforce needs and by promoting the quality of these programs, we have significant opportunity to increase enrollment in the diversity of sub-disciplines supported by biology programs.

4. Report

a. Background

i. Brief Description of Team's Activities

The team met in face-to-face meetings on September 26, 2015 and November 13, 2015. Several meetings in between and after these meetings were held via Google Hangout. Communication by email and sharing files on the Google Drive set up by Tina Baughman comprise the remainder of activity. Discussions focused mainly on the 5 areas of the charge, but, also involved some discussion of the nature, feasibility, and rationale for this effort. Part of the discussion was delayed, because in order to determine the equivalency of learning outcomes and course numbering for the 100- and 200- level foundational courses, we first needed a grid of equivalencies. This equivalency table was made available until Tuesday, February 9, but, since there may have been some errors in the table (courses included that are not known to be equivalent), we supplemented this information with equivalencies compiled directly from the MaineStreet portal. Much of the report was written and final discussions took place after this, in the final two weeks of February.

ii. The Role of Biology at each Campus and the UMS

Biology is the most popular science discipline on university campuses across the nation and within the University of Maine System. It is an integral part of the vast majority of college and university curricula because of its importance to students individually and society as a whole. Biology programs on each campus serve a variety of essential functions which include providing training for biology and pre-professional majors, offering courses to a wide variety of other environmental science, professional, and allied health majors, and furnishing the single, most popular science course that students select to fill the science requirement associated with the general education curriculum. The inherently hands-on aspect of this laboratory or field-oriented discipline means that much of the delivery of biology content in introductory and especially upper-level courses necessitates on-site course delivery. While there is some opportunity to meet distance education needs in the general education, service coursework or major, much of the biology curriculum needs to be delivered in faculty-led meetings. Beyond the campus boundaries, biology programs and their students support technological innovation, help gather information and develop initiatives for the management of natural resources, and do the basic research needed to understand life on earth. These activities provide a real and valuable benefit to the people and state of Maine.

Each of the seven UMS campuses, in addition to their service to the campus, also are connected to a variety of external local, regional and national stakeholders. These include, for example, biotechnology and biomedical research laboratories and firms, such as Idexx, MDI Biological Lab, and Jackson Lab; state and federal agencies, such as Maine Inland Fisheries and Wildlife, Department of Environmental Protection, U.S. EPA; a variety of grantors including National Institutes of Health, National Science Foundation, Howard Hughes Medical Institute. Taken together, this statewide network of educational and research collaboration is substantial. However, despite this infrastructure we are losing ground to more strategic competitors who lack the depth, breadth, and geographic extent as the biology program within the University of Maine System. An overview of the role of biology at each campus follows. One clear

opportunity is to better connect our individual campus resources, as this is a clear case of 'the whole is greater than the sum of the parts'. Appropriately coordinated, leveraged, and marketed, we have great potential to increase enrollment and financial sustainability, whereas several of our higher-priced private competitors have been gaining ground in this area in recent years.

University of Maine at Augusta

Degree Offered: BA in Biology

The Augusta-based Biology degree program supports UMA's mission statement in three essential aspects: 1) It meets the educational and economic needs of the Central Maine and capital region of the state, by graduates who contribute technical, analytical, and scientific skills to a competitive and evolving work environment, 2) It provides laboratory science service courses for all degree programs as part of the liberal arts core, and 3) It allows for professional growth for graduates of medical laboratory technology associate degree program through the Biology/MLT 2+ 2 degree.

The Biology program at UMA combines a firm foundation in the liberal arts with courses in biology, chemistry, physics and mathematics to provide the foundations needed for advanced work in the biological sciences. Science electives enable students to build expertise in an area of special interest. Beyond course and lab work, the Biology department also offers the student opportunities to work directly with faculty on innovative scientific research projects, or intern at a collaborating institution such as the Maine Health and Environmental Testing Laboratory of the Department of Health and Human Resources, or volunteer in Haiti as part of a course in global health.

Rigorous learning outcomes ensure that graduates will reach their aspirations and be prepared for a rewarding professional career. UMA's Biology majors graduate with a broad spectrum of career options. Many of our graduates have obtained positions in laboratory science in both the public and private sectors and in education, while others have pursued graduate study in the biological sciences, medical school, and in allied health programs leading to careers as a physician's assistant or pharmacists. Biotechnology, environmental monitoring, and research laboratories are other possibilities for the UMA Biology graduate.

University of Maine Farmington

The Biology Program at UMF offers two different tracks - one for 'traditional' biology majors (BA) and the other for pre-health professional school students (BA). In addition, introductory and upper level courses in the program serve both the secondary education life science (BS) and environmental science (BS) majors. Non-majors are served by separate, specially designed courses. Traditional biology majors learn science as a 'process', they are exposed to a wide range of observational, experimentation, sampling, and analytical techniques, they learn to communicate research results in both technical report and public presentation formats, and they graduate prepared for entry level career positions or admission to graduate/professional schools. Pre-professional majors take core biology courses and additional chemistry and physics courses in preparation for admission to professional health careers or biomedical research programs.

Sub-disciplines emphasized at UMF include molecular and microbiology, organismal biology, and ecology. Specific areas of faculty and student research include molecular biology, microbiology, endocrinology, physiology, bioinformatics and population genomics, aquatic ecology, marine ecology, insect ecology, avian ecology, forest ecology, behavioral ecology, and conservation biology. UMF faculty presently have research collaborations with staff at UM, UMPI, UMA, USM, MDIBL, Colby College, and the Maine Department of Inland Fisheries and Wildlife.

University of Maine Fort Kent

Biology students at UMFK focus on one of four specializations including Ecology, Zoology, Botany and Biomedical Science. The biology program also provides many required support courses for the Nursing, Conservation Law, Forestry and Environmental Studies programs. In addition, biology courses are frequently used to fulfill general education requirements, usually the Natural Science requirement. Courses in UMFK's biology program are also a part of the field Experience Program (FEP), which brings students on single day to weekend excursions and two extended field trips to areas that fulfill and enhance student learning outcomes in the participating biology courses. The UMFK's biology program runs the Rural U EcoOutreach program designed to garner interest in biology from high school students around Maine through a curriculum focused on plant-animal interactions.

Faculty and students in UMFK's biology program conduct research focused on local and state scientific and management issues unique to northern Maine. Funding and support for faculty and student research in biological sciences at UMFK comes from MEIF-SCI, NASA, National Geographic, National Park Service, U.S. Forest Service, Howard Hughes Medical Institute and the Maine INBRE (via a NIH grant). UMFK biology faculty (n=4) research includes local (white tailed deer GPS/satellite tracking, vegetation ecology on state lands, water quality monitoring; vector-borne diseases), national (climate change experiments in Minnesota, remote sensing and mapping of vegetation in Alaska) and international (vegetation disturbance ecology and pulse-resource dynamics under extreme aridity in Chile) domains of inquiry.

Recent graduates from UMFK's biological sciences programs have pursued graduate degrees, work in biomedical sciences and public land management agencies.

University of Maine Machias

The Biology program at UMM focuses on experiential learning. Nearly every course in the Biology major has a required laboratory section where the focus is on providing hands-on opportunities for students to learn and use marketable field and laboratory skills ranging from biotechnology to natural resources management. Biology majors may choose to concentrate their studies in Fisheries Biology, Wildlife Biology, or Pre-professional Biology (Pre-Med, Pre-Vet, Pre-Pharmacy, and Pre-Physical Therapy). The program predominately serves traditional-aged full time residential students. The Biology program interacts closely with the Marine Biology, Environmental Studies, and GIS programs at UMM, providing our students with even more opportunities to acquire marketable skills. Students in the Biology major have opportunities throughout the major to meet and interact with alumni and employers who provide valuable career information and advice.

UMM's Biology graduates work in natural resource management agencies and in the growing biotechnology industry in Maine (Jackson Laboratories, IDEXX, Mount Desert Biological Laboratories, etc.). Additionally UMM's Biology majors have gone on to study at prestigious veterinary schools, pharmacy schools, medical schools, and graduate programs.

UMM Biology faculty collaborate with 11 other institutions in the Maine INBRE program to provide intensive courses, internships, and career training for students in the biotechnology and medical fields. Additionally Biology faculty form close partnerships with state and federal agencies and non-governmental organizations focused on fisheries and wildlife management and conservation, including Maine Department of Marine Resources, Maine Department of Inland Fisheries and Wildlife, Maine Warden Service, National Marine Fisheries Service, US Fish and Wildlife Service, Downeast Coastal Conservancy, and Downeast Salmon Federation. Our students and alumni work with these agencies as interns or in contract positions, and students in our courses complete projects for them.

Biology faculty and courses support the Conservation Law concentration in the ERTM program. This concentration was developed specifically in response to requests from the Maine State Warden Service. The Maine Warden Service has requested we set up a Wildlife Forensics Laboratory to process samples for potential prosecution. This will tie the Wildlife Biology concentration with Conservation Law concentration in ERTM. UMM's herbarium contains approximately 2,000 specimens of vascular plants and an additional modest collection of non-vascular plants, lichens, and marine macroalgae. Additionally UMM houses an entomological collection and a wide variety of articulated skeletons, all of which have been articulated by students. These natural history collections are in the process of being digitized by biology majors so that access to this valuable resource will be greatly facilitated.

University of Maine Presque Isle

Biology students at UMPI primarily enroll in one of two concentrations for a B.A. in Biology: 1) pre-medical biology - which serves the wide range of pre-professional interests, and 2) a concentration in ecology, evolution, and biodiversity (formerly called 'professional'). A self-designed concentration is also available and provides flexibility for students with prior biology or science coursework to attain a B.A. in Biology. The majority of biology majors are aspiring to professional or graduate schools, while some are seeking employment after graduation. Recent graduates have been accepted to various medical, osteopathy, dental, optometry, veterinary, physician assistant, histology, or other graduate programs. Some graduates return to work locally (e.g. for U.S. customs or as a P.A.), whereas others seek employment beyond Northern Maine. The biology program also delivers courses required by athletic training, physical therapy assistant, social work, environmental science, sustainable agriculture, secondary education (biology) and the general education. There is modest demand for local biology education on either side of the border, but one of the challenges has been communicating the potential for success as a graduate of our program. All biology faculty (n=4) have active research programs which garner small to modest grant support (NSF, USDA, Maine Outdoor Heritage Fund, Maine Potato Board, INBRE), publish in peer-reviewed journals, and connect to local and regional issues of importance, e.g. climate change, land use, antibiotic resistant bacteria, infectious disease, genetics, pollinator health, and soil health. Our research expertise also connects us to local hospitals, natural resource agencies, agriculture, and the local band of Micmacs.

Research and teaching expertise spans ecology (forest, microbial, physiological), microbiology, plant genetics, neuroscience, entomology, ornithology, soil science, and forestry. UMPI faculty have existing collaborations with UM, UMA, UMFK, as well as a variety of other non-UMS faculty or professionals. The Biology and Environmental Science programs also host a seminar series that brings professionals and faculty to campus (including from across the UMS).

University of Maine

The School of Biology and Ecology serves as a central home for research and teaching programs in organismal biology and ecology at the University of Maine. Our areas of inquiry span biology in both scale (cellular to global) and discipline (genetics and developmental biology to ecology and biogeochemistry).

Undergraduate Education

Undergraduates at the School of Biology and Ecology pursue a wide variety of careers, in both basic and applied aspects of biology that range from cellular biology to ecology. A significant proportion of students plan to enter the healthcare field. The department provides a major academic home for students wishing to pursue pre-med and other health profession careers, and offers a Clinical Laboratory Sciences (CLS) program and a concentration in Pre-Medical Studies. Our Clinical Laboratory Sciences faculty coordinates with staff at EMMC to provide practical, hands-on experience for students in the CLS program, and the faculty members work with the pre-health professions advisor and other units on campus to assure a strong basis in organismal biology necessary for success in these professions. The concentration in Pre-Medical Studies offers guidance to students preparing for a career in medicine or in any other health profession. Many of our students are interested in research careers with animals, plants, and fungi, careers in agriculture, and careers related to the environment. The School of Biology and Ecology recognizes the significance of a solid foundation in organismal biology integrated with an understanding of ecology and evolutionary principles in meeting today's environmental and human health issues, and to meet this demand, SBE offers exceptional undergraduate degree programs in Biology, Zoology, Botany, and Clinical Sciences. The coursework required of each program is rigorous and spans the sub-disciplines of biology and ecology, including the basic principles of structure and function, physiology, genetics, and development. A key feature of these degree programs is the wide choice of courses to meet each of the required areas, allowing students a degree of freedom to design their degrees to reflect and engage their particular interests. SBE provides high quality basic introductory biology service courses (i.e. BIO 100, BIO 200, BIO 222, and BIO 208) for the biologically based disciplines within the College of Natural Sciences, Forestry, and Agriculture, the nursing program, and the University community as a whole. Additionally, students interested in ecology may select an Ecology concentration within the School of Biology and Ecology.

Graduate Education

For graduate students, the School offers Master of Science (M.S.) degrees in Biological Sciences, Entomology, and Zoology, and Doctor of Philosophy (Ph.D.) degrees in Biological Sciences and Zoology. SBE participates in interdisciplinary degree programs, such as Doctor of

Philosophy in Plant Science, Masters in Botany and Plant Pathology and Master's and Doctoral degrees in Ecology and Environmental Sciences.

University of Southern Maine

The biology program at USM offers an undergraduate major and a masters degree both of which emphasize a broad, solid foundation in the biological sciences. The major includes required courses in chemistry, math, and physics. In part because our neighboring institutions offer specialized degrees, nine years ago the USM biology major was modified so students select a concentration within the major: either the existing general biology major, or new concentrations in biotechnology, human biology, and ecology. These areas of specialization provide a good indication of the dominant career interests of USM biology students as well as career opportunities in the immediate area. Since introducing the concentrations, the number of biology majors has more than doubled.

Students in USM biology classes include: 1) biology majors, 2) several other majors that require biology courses (e.g., nursing, occupational therapy, athletic training, psychology, biochemistry, exercise science, computer science, environmental science), 3) students completing the general education requirement in Science Exploration, 4) graduate students in the masters program, and 5) high school students in aspire programs.

The philosophy of the biology faculty is to provide hands-on, research-focused experiences in lab courses as well as independent research with faculty mentors. These are resource-intensive experiences but are absolutely essential for career development. Student demand significantly outstrips faculty capacity in part because five tenured biology faculty retired in the past four years and five tenured medical biology colleagues with research programs were lost through retrenchment. During that time, two faculty were hired, but as non-tenure track instructors with no expectation of research. Nevertheless, the biology program is succeeding with high enrollments, newly renovated classroom labs, and new opportunities for grants and collaborations enthusiastically pursued. Examples of the latter include strong, expanding internship programs with local biotech companies such as IDEXX and health training institutions such as Maine Medical Center.

Most students in the Masters program in biology have been interested in ecology and conservation. This has led to excellent collaborations with several adjunct faculty off-campus as well as with faculty in the USM environmental sciences program. The highly collaborative nature of the relationship between biology and environmental sciences faculty was strengthened by replacing the ecology concentration in biology with a minor in environmental science. Now students are encouraged to major in either program and minor in the other. Environmental science faculty provide invaluable research mentoring for undergraduate and masters students in biology.

Biology faculty and our students participate in rapidly expanding STEM outreach teaching and service learning opportunities through programs coordinated by the USM office of Community Engagement and Career Development (e.g., 4H STEM Ambassador Program, Learning Works, Make It Happen, Southern Maine Partnership). A new track in the biology major provides teacher certification.

B. Recommendations

i. Recommendations and Indicators to Improve Quality

1. Establish a UMS-wide biology website to highlight all of the biology academics, faculty, resources, and opportunities statewide. This could include news, blogs, community of sharing ideas, e.g. projects with high schools, course sequence info for each campus (MaineStreet only has current semester), undergrad research opportunities, and a list of field sites or special resources (unique equipment or collections) at each campus, with suggestions about how to use them, e.g. for class field trips.
2. Create a UMS biology symposium, held annually, that will bring together faculty, undergraduates, and graduate students from each campus. A 1-2 day schedule could include faculty/student talks, poster sessions, workshops, plenary speakers, as well as faculty meetings to discuss curricula and intercampus collaboration and coordination. By coordinating with Maine INBRE, and large biological science employers such as Idexx, Jackson Lab, MDIBL, State of Maine, and others we could also host a statewide job fair.
3. Further embed high impact teaching practices such as those promoted by the American Association of Colleges and Universities (<https://www.aacu.org/leap/hips>) into Biology programs. These include writing intensive courses, service learning, internships, capstone courses, and undergraduate research. Biology programs on all campuses are already making extensive use of these approaches, as these are the approaches needed to produce graduates who are successful gaining employment or admission to graduate or professional school. What is needed is better promotion and marketing about the strengths of these programs at all of the UMS campuses, i.e. the successes achieved by our students and the professional accomplishments of our faculty.
4. Develop more explicit relationships and collaborations with non-academic partners to support internship opportunities, career pathways, and program advisement. Faculty already have many relationships with state and federal agencies, non-profits, and biotechnology companies and research laboratories. Increasing formal internship programs will better prepare and inform our students on career pathways. A statewide biology advisory board could be formed to allow industry and research entities opportunity to inform our programs about changing needs in this dynamic and diverse employment sector.

ii. Recommendations and Indicators to Improve Access and Enrollment

1. Align course learning outcomes for foundational courses, where possible, and better establish and communicate 100 and 200-level course equivalencies across campuses.

There is already substantial alignment of 100- and 200- level courses across the seven UMS campuses, and a further analysis should determine if there are additional courses that could be determined to be equivalent. Adding additional courses to the existing courses may just require more careful examination (without course changes), or in some cases, may require slight curricular changes within a course. A particular focus on the introductory course sequence for majors, anatomy and physiology, and some other second-year courses will be most productive. However, not all courses should necessarily be aligned, especially where a course serves a different function at one campus versus another (e.g. nursing students vs. environmental biologists), and is contradictory to campus differentiation. Substantial re-numbering would be a very time-consuming and disruptive process for students, faculty, and registrars. However, it would be possible to do this for many of the courses that are already considered equivalent. We may also want to better define 200, 300, and 400 level courses, so

that similar courses across campuses are at the same level. This may require some re-numbering, or at least, a consistent numbering practice moving forward.

2. Improve processes for existing, prospective, and transfer students to determine course equivalencies across the UMS. Mainstreet presents a relatively user-unfriendly (especially on tablets or smartphones), slow (a couple minutes per course search), transfer equivalency tool which is poorly known. Despite significant effort by registrars, faculty, and administrators to establish equivalencies within the UMS and for many other universities and colleges, access could be improved.

3. Create more effective ways for current students to search for and enroll in courses across all seven campuses simultaneously. MaineStreet currently only allows a current semester search or a catalog search with each campus. Upper level courses that may be rotated infrequently or online courses are of special interest to students who may be able to complete their graduation requirements if other campuses courses are more searchable. Furthermore, a two-year rotation or more clear communication of when courses will be offered would allow more coordination and student course planning. Make the process of enrolling in another UMS course easier, i.e. able to be done by the student within MaineStreet, rather than contacting advisors, registrars, financial aid, etc.

4. Evaluate, develop, and publicize specific cross campus collaborations that may be technologically feasible and result in critical mass that may not be present within a single campus. For example, there are neurobiologists at several campuses, and these faculty could coordinate their courses and other academic/research experiences to develop a stronger offering for students.

5. Further invest in select classrooms/laboratories (e.g. one per campus), other technology, and IT human resource support, to facilitate distance education or other strategic course offerings across campuses as well as the University College centers. This will enable some increase in distance education for select courses and allow faculty to consider hybrid models for some upper-level courses to simultaneously use faculty resources more efficiently, as well as expand opportunity for students. For example, if a lecture section of a course (e.g. Lichenology) could be taught via distance education and available to another campus, a lab section could be instructed by a faculty member at another campus (but only if a qualified faculty member is in residence). This would increase access to courses not currently offered at some institutions, as long as there is a critical mass to run the respective lab sections. While this would not be a widely used teaching approach, it would add value and increase efficiency through select offerings.

6. Biology programs support a substantial or predominant part of the college coursework of roughly 47% of the anticipated majors of graduating high school students (Appendix, Table 1). There are a number of sub-disciplines which UMS already provides a higher percentage of graduates. However, there are some sub-disciplines that are underrepresented, and based on potential employment sector growth, these could be targeted for growth, including, e.g. rehabilitation and therapeutic professions, general biology, health and fitness, and health and medical administrative services. This latter discipline is a good exemplar of where UMS is not meeting emerging workforce needs (see recommendations iii.4-5), but, has the expertise (e.g. existing science, business, and management departments and courses).

iii. Recommendations and Indicators to Improve Productivity and Financial Sustainability

1. Develop a coordinated schedule of upper-level courses to both improve temporal access to promote degree progress as well as reduce redundancy in offerings. This recommendation may only be possible in limited cases, where students may easily take a course through another campus (e.g. through study away or proximity). Most students do not want to physically take courses at another campus, unless they actually transfer.
2. Develop a graduate student teaching fellowship program. Graduate students from USM and UM could receive a fellowship to spend 1-2 semesters at another campus and teach a course or two, under the mentorship of a faculty member. This could be an existing campus course, or a specialty course within the graduate students expertise. Fellowships would require a stipend and/or housing and board. This experience would strengthen the graduate student's CV, connect undergraduates with our graduate programs, and likely have lower course instruction costs. Graduate students could continue their research and thesis work during this time.
3. Develop statewide research collaboratives that will lead to multi-campus grants, such as, NSF's Research Experience for Undergraduates program (REU), or other collaborative research grants. These grants generate indirect funds for campuses, but, more importantly increase the quality and visibility of the academic experience, and thus, will enhance recruitment. There are many collaborations among faculty across all the UMS campuses, but, the research capacity of biologists in the UMS is probably underappreciated and underutilized.
4. Develop a strategic, UMS-wide marketing and student recruitment strategy to serve the diversity of biological disciplines and career paths. Highlight the multiple campuses, of different sizes, subdisciplinary emphases, and locations from coastal to inland, urban to rural. This may require a shift in admissions recruiting approaches, professional development for admissions; for example, it may need an admissions officer who is knowledgeable of the breadth of opportunities in biology across the UMS. Also, consider using a wider diversity of named programs, majors, or concentrations (as e.g. Unity College is adept at doing) that could be completed with our existing set of offerings and expertise.
5. Facilitate more responsive strategies to provide academic programs to meet changing student and workforce needs. The UMS needs to be more strategic about adapting to changing workforce needs by identifying how existing (or occasionally new) faculty expertise and infrastructure could support emerging career sectors. Two obvious changes are needed: 1) someone with a good understanding of the UMS resources and emerging careers/majors that could be pursued, and 2) an easier process for faculty to adapt or create new majors. Currently, a new major needs to be approved at the chancellor/board of trustee level. While this may continue to be an expectation, the current process, overall, does not facilitate a deliberate and timely response to changing education needs of biology-related established and emerging careers.

c. Capabilities, Policies, or Other Requirements to Support Implementation

1. A collaborative system-wide level of support is needed for recruitment and promotion, course equivalencies, and web presence.

2. Information technology (IT) is a key supporting capability that is implicated by a number of the recommendations in this report. There are many aspects of biology program's quality, efficiency, and access that could be improved through better IT practices, i.e. workflow management, technical support of teaching and other program initiatives, customer service and technical capacity, and management of MaineStreet to provide improved access to data for faculty, staff, current students, and prospective students.
3. Depending on the level of statewide collaboration, there may be a need to be a person (a biology faculty) on each campus to coordinate these collaborations.
4. A small increase in travel budgets may be needed to facilitate statewide collaboration, symposia, etc. However, faculty expect that we may be able to successfully reach out to private sector stakeholders (e.g. Idexx or Jackson Lab) who may sponsor such statewide symposia.

5. Appendix

Table 1: Percentage of college bound HS seniors indicating interest in specific majors (NRCCUA - NE)

MAJOR	Class of 2011	Class of 2012	Class of 2013	Class of 2014	Class of 2015	Change: 2011 to 2015
Nursing/Health Care	7.7%	8.3%	9.0%	8.8%	8.3%	0.6%
Psychology/Psychiatry	7.7%	6.1%	5.8%	5.4%	5.3%	-2.5%
Doctor/Physician	7.6%	7.1%	6.3%	5.5%	4.5%	-3.1%
Teaching/Education	6.8%	5.7%	4.9%	4.3%	4.1%	-2.7%
Biology	4.3%	4.2%	4.1%	4.5%	4.9%	0.6%
Science	3.2%	3.5%	3.0%	3.1%	2.4%	-0.8%
Physical Therapy	2.4%	2.2%	2.4%	2.5%	2.5%	0.1%
Chemistry	1.8%	1.7%	1.5%	1.4%	1.4%	-0.3%
Veterinary Medicine	1.6%	1.7%	2.1%	2.2%	2.2%	0.6%
Pharmacy	1.4%	1.4%	1.4%	1.4%	1.3%	-0.1%
Marine Biology	1.3%	1.6%	1.8%	2.0%	1.8%	0.4%

Dental Health	1.3%	1.1%	1.2%	1.3%	1.1%	-0.2%
Environmental Studies	1.1%	1.1%	1.1%	0.9%	0.9%	-0.2%
Medical Technology	1.0%	1.1%	1.1%	1.3%	1.1%	0.1%
Physical Education/Recreation	0.6%	0.6%	0.8%	0.9%	0.9%	0.3%
Forestry/Conservation	0.5%	0.5%	0.5%	0.5%	0.5%	0.0%
Agricultural Sciences	0.5%	0.5%	0.4%	0.5%	0.4%	-0.1%
Equine Studies	0.4%	0.5%	0.5%	0.5%	0.4%	0.0%
Engineering (Chemical)	0.1%	0.4%	0.5%	0.8%	0.8%	0.7%
Earth Sciences/Geology	(*)	(*)	0.0%	0.1%	0.2%	
Medical Science	(*)	(*)	0.0%	0.5%	1.7%	
Number of College-bound HS Seniors Surveyed	82,502	80,181	70,993	62,938	65,248	
				Total	46.6%*	

*This total for Maine is 48.3%

Table 2: Maine Baccalaureate degrees by biology subdiscipline, 2013

DISCIPLINE	All schools, all years combined	UM System, all years combined	UM System Share	UM System share INDEX	Rank
01.10: Food Science and Technology.	170	170	100%	1.81	12
01.09: Animal Sciences.	127	127	100%	1.81	14
30.32: Marine Sciences.	101	101	100%	1.81	15
26.05: Microbiological Sciences and Immunology.	43	43	100%	1.81	20
51.22: Public Health.	41	41	100%	1.81	21

14.03: Agricultural Engineering.	35	35	100%	1.81	23
26.03: Botany/Plant Biology.	12	12	100%	1.81	24
14.38: Surveying Engineering.	6	6	100%	1.81	25
14.05: Biomedical/Medical Engineering.	4	4	100%	1.81	26
03.05: Forestry.	96	87	91%	1.64	16
13.13: Teacher Education and Professional Development, Specific Subject Areas.	821	727	89%	1.60	4
13.12: Teacher Education and Professional Development, Specific Levels and Methods.	2,153	1,828	85%	1.54	2
01.06: Applied Horticulture and Horticultural Business Services.	75	59	79%	1.43	19
13.99: Education, Other.	37	27	73%	1.32	22
51.38: Registered Nursing, Nursing Administration, Nursing Research and Clinical Nursing.	2,164	1,512	70%	1.27	1
31.01: Parks, Recreation and Leisure Studies.	76	51	67%	1.22	18
03.06: Wildlife and Wildlands Science and Management.	143	93	65%	1.18	13
51.23: Rehabilitation and Therapeutic Professions.	348	191	55%	0.99	7
26.01: Biology, General.	1,625	600	37%	0.67	3
26.02: Biochemistry, Biophysics and Molecular Biology.	304	100	33%	0.60	8

03.01: Natural Resources Conservation and Research.	780	254	33%	0.59	5
03.02: Natural Resources Management and Policy.	191	45	24%	0.43	11
26.07: Zoology/Animal Biology.	200	47	24%	0.43	10
31.05: Health and Physical Education/Fitness.	539	104	19%	0.35	6
26.13: Ecology, Evolution, Systematics, and Population Biology.	273	39	14%	0.26	9
42.28: Clinical, Counseling and Applied Psychology.	90	12	13%	0.24	17
51.07: Health and Medical Administrative Services.	176	0	0%	0.00	#N/A
01.11: Plant Sciences.	0	0	0%	0.00	
ALL DISCIPLINES TOTAL	38,555	21,278	55%	1.00	