



Office of the Director

Date: October 12, 2010

To: Virginia Sapiro, Dean of Arts and Sciences

From: John Finnerty, Director, Boston University Marine Program (BUMP)

Re: Self Study: Planned curriculum improvements and their budgetary impacts

Cc: Michael Sorenson, Chair, Biology
Mark Friedl, Chair, Earth Sciences
Robert Kaufmann, Chair, Geography & Environment

I. Overview

In our fifth year since relocating from Woods Hole to Boston, and our third year as a stand-alone major, BUMP has achieved several important milestones. We have grown to more than 70 majors and enrollment trends suggest that the major is still growing (Appendices A-D). We graduated fifteen students at the first Marine Science commencement in May. We launched the 25th annual Marine Semester in September. In short, we are delivering on our promise “to provide a rigorous, interdisciplinary education in marine science to undergraduates.” However, we continue to refine and improve our curriculum—particularly the courses offered in the Marine Semester—so that we may better serve the needs of Marine Science concentrators and a host of other CAS students.

II. Refinements and Improvements to the Marine Semester

The FY2012 budget request reflects the following objectives for the Marine Semester.

- (1) To develop a financially sustainable slate of compelling Marine Semester courses.
- (2) To continue ongoing efforts to address curricular gaps in the Marine Semester.
- (3) To accommodate the expected increase in enrollments in 2011 and 2012.

(4) To accommodate a more academically diverse body of Marine Semester students.

A. Towards Achieving a Financially Sustainable Slate of Courses. The Marine Semester is inherently expensive. However, our 2-block sequence in Tropical Oceanography (ES545/546) is substantially more expensive than our other course offerings (2008: \$390K; 2009: \$390K; 2010: \$350K). In 2009, partly motivated by cost-containment, we decided to move to an alternating 2-year slate of Marine Semester courses. Under this plan, ES545/546 would have been offered only in even-numbered years. However, as no funds appear forthcoming to offer ES545/546 beyond 2012, we have concluded that it is in the best interest of BUMP to cease offering ES545/546 after 2010 and to invest in the development of alternative field-based courses for Blocks 3 and 4 of even-numbered years going forward. The development of new courses is discussed below.

Note: The decision to discontinue ES545/546 after 2010 was made by the current director after consulting with the course instructor and former BUMP director, Rick Murray. Professor Murray is in complete agreement with this decision.

B. New Course Development to Address Curricular Gaps in the Marine Semester. The problems confronting contemporary marine science are inherently interdisciplinary—hence the motivation for developing an interdisciplinary marine science program. If our students are to comprehend the complex and multifactorial problems facing marine science, the Marine Semester must provide meaningful coverage of (1) the essential content areas of modern marine science (Appendix E), (2) the major taxonomic groups of marine organisms (Appendix F), (3) the major marine environment types (Appendix G), and (4) the technical skills required to practice marine science (Appendix H). When the new interdisciplinary Marine Science major first received formal approval in 2008, the Marine Semester itself was not sufficiently interdisciplinary as it lacked significant coverage of the following areas: biogeochemistry/nutrient cycling; genetics/genomics; molecular biology; microbial biology; climate/global change; environmental contamination/marine pollution; marine policy; scientific diving. As described below, we made progress towards addressing the curricular gaps of the Marine Semester in 2010, and we will continue to make progress in this regard in 2011 and 2012.

1. 2010

In November 2010, we will launch a new course in **Marine Genomics (BI 550)**. This course will expose our students to cutting edge technologies while addressing the curricular deficits in molecular biology, genetics, and genomics. Students enrolled in the course will participate in the sequencing of a coral genome.

2. 2011

In 2011, we will launch three (or possibly four) new courses.

a. Coastal Nutrient Cycling (ES ###) Professor Wally Fulweiler will offer this course in odd-numbered years beginning in 2011. This will be a travel course in a warm weather venue, perhaps the same site at Wee-Wee Caye, Belize, where Professor Lobel (BI) has safely and successfully run his expeditionary Ichthyology course for the last 14 years. Alternately, the course may be held at a Gulf Coast site in the US (via the Louisiana Universities Marine Consortium). The projected expense of this course is \$35K in 2011 and odd-numbered years thereafter. It will focus on biogeochemistry and nutrient cycling. It will also provide meaningful coverage of microbial biology, environmental contamination, and marine pollution.

b. Coral Reef Dynamics (BI/ES ###) Professor Kaufman is preparing a new Marine Semester course that will focus on the microbial-animal symbioses that underlie coral reef functioning and the biogeochemistry of reefs. This will be a one-block course with a field component in Belize and a lab component in the Marine Teaching Lab (BRB B25). The projected expense of this travel block is \$35K in 2011 and odd-numbered years thereafter. In addition to its focus on coral biology, this interdisciplinary course will provide significant coverage of biogeochemistry, nutrient cycling, microbial ecology, marine pollution, and climate change as well as limited coverage of marine policy.

c. Scientific Diving (MR ###) Scuba diving is an essential technical skill in marine science, and many of our graduate and undergraduate students come to BU already trained as recreational divers or with a stated interest in becoming competent divers. For many students, one of the most attractive features of the marine semester is the opportunity to gain experience in scientific diving in Professor Lobel's field ichthyology course. As the instructor of this course and the Dive Safety Officer at BU, Prof. Lobel

has helped numerous BU graduate students and undergraduates to attain certification as scientific divers according to the strict qualifications set forth by the National Oceanic and Atmospheric Administration—qualifications that are much stricter than those used to attain the status of “recreational diver.” Indeed, in order to safely and effectively execute his Belizean Coral Reef course, Prof. Lobel requires at least two TFs that are experienced scientific divers. However, the number of persons that Prof. Lobel can certify as scientific divers on an *ad hoc* basis is severely limited. In order to meet the need for BU graduate and undergraduate students to become certified scientific divers, Prof. Lobel is designing a course, intended for the second summer session, which would culminate in the successful student achieving this certification. The course would be designated as a Marine Science course (MR####), and it would appeal to marine science concentrators as well as graduate students, post-docs, and faculty doing research in the marine environment from a range of departments including Biology, Earth Sciences, Geography and the Environment, and Archaeology. In addition, the course will appeal to students and staff from neighboring Universities with labs engaged in marine research including Harvard and MIT. The course would cost \$6,000 (not counting Prof. Lobel’s salary as instructor), and given the urgent need for scuba training among the graduate students of multiple BUMP faculty and the strong demand for such a course among marine science concentrators, we had hoped to launch this course in the summer of 2010, but we are now planning to launch the course in summer of 2011.

d. Marine Policy: The BUMP faculty voiced unanimous support for developing a course in Marine Policy at a meeting on September 27, 2010. It was suggested that Jud Crawford would be an ideal instructor. Dr. Crawford is an adjunct faculty member in the Biology Department, and he is already associated with BUMP. He is currently the Science and Policy Manager in charge of the New England Fisheries Campaign at the Pew Environment Group. He worked previously as chief scientist for The Conservation Law Foundation, where he focused on marine issues. Prof. Finnerty has initiated discussions with Dr. Crawford regarding a Marine Semester course in marine policy. If Dr. Crawford is able to teach such a course, it could be offered as early as 2011. If Dr. Crawford is unable to teach the course, BUMP will continue to explore other options for developing a course in marine policy.

3. 2012 and beyond

a. Replacing ES545/546: The principal challenge for 2012 is to develop field courses in Blocks 3 and 4 that can replace ES545/546. The course development process will begin in earnest at the BUMP faculty meeting scheduled for October 18, 2010.

b. Sedimentology: Professor Duncan Fitzgerald (ES) has recently suggested that his existing course in sedimentology (ES331) would make an ideal block course. The BUMP faculty expressed enthusiasm about this possible development. At a recent meeting with Prof. Friedl (chair of ES), Professor Finnerty conveyed BUMP's willingness to aid the development of such a course in any way that we can.

C. Insufficient Enrollment Capacity of the Marine Semester. All students in the Marine Science major are required to take the Marine Semester, so the capacity of the Marine Semester limits the size of the major. In Fall 2009, the Marine Semester essentially reached its carrying capacity in blocks 3 and 4. This would be tolerable if the enrollment in the major was static or declining. In 2010, enrollment in the Marine Semester is actually slightly down from 2009 (Appendix D). However, this slight decrease is a demographic blip that reflects the low number of entering Marine Science freshmen in 2007/2008 (Appendix A). This represents a "gap year" in our recruiting because the specialization in Marine Science for Biology majors was being phased out, but the standalone Marine Science Major had not yet been formally approved. However, relative to 2007/2008, **2008/2009 and 2009/2010 saw a significant increase in the number of entering freshmen declaring Marine Science, and the current Marine Science discussion section of ES144 (Appendix C) is over-enrolled (with 40 students), nearly all freshmen and sophomores**). As the Marine Semester is taken primarily by juniors and seniors, we can expect enrollment in the Marine Semester to exceed 40 students in 2011 and 2012.

In addition to Marine Science concentrators, the Marine Semester serves a number of different student populations, including undergraduates from Biology, Earth Science, and Environmental Science, in addition to graduate students from Biology and Earth Science. In 2010, the Marine Semester is also serving our first Psychology major and our first Bioinformatics graduate student. Furthermore, to broaden our service to BU and to more fully realize the interdisciplinary promise of BUMP, In the near future, we hope to begin actively advertising the marine semester to those students from other science

majors who have an interest in the marine environment (e.g., Chemistry; Physics). As discussed with past and current chairs of Earth Sciences, ES courses offered during the Marine Semester might also be used by Earth Science undergraduates to satisfy that major's requirement for field research. We also intend to market the Marine Semester directly to Environmental Science majors who might otherwise use research semesters offered by the School of Fields Studies to count towards the requirements of their major. Furthermore, the marine semester should appeal to highly motivated students from the social sciences or humanities whose scholarly or professional interests extend into marine policy or marine industries (e.g., students majoring in History, International Relations, or Political Science). Finally, our past experience with the Marine Semester in Woods Hole reveals that this educational opportunity is sufficiently appealing that it can regularly attract students from other universities; this generates revenue for BU and fosters BU's reputation for educational excellence.

D. Urgent Need for Renovation in the Marine Teaching Lab: In addition to adding courses, we must also expand the capacity and integrity of the Marine Teaching Facility. As discussed in the Biology Department's 2012 budget request, there is a pressing need to renovate BRB27/27a to both provide additional space for student research and to address a potentially serious design flaw in the aquarium system, namely the mixing of warm water and cold water streams. The relevant passage from the Biology budget is excerpted here:

"Since the BU Marine Program (BUMP) moved to the Charles River campus from Woods Hole, enrollment has steadily increased and new courses have been added. Currently, the BUMP program is housed in the basement of 5 Cummington St. and the opportunity for a much-needed expansion is available. We are requesting funding for a minor renovation of rooms B27 and B27A. The requested renovations include the installation of new floor drains as well as an upgrade to the HVAC system, both intended to protect and improve the building and aquarium facilities.

The renovated space would give us much-needed experimental space for multiple upper-level courses in which students conduct independent projects. The Marine Invertebrate Biology, Sensory Biology, Marine Megafaunal Ecology, Ichthyology and the Introductory Marine Biology classes would all use the new space. In addition, it would also give us more space for culturing live foods, raising juvenile fish that are produced in our tanks and culturing invertebrates that we use in the classes (shrimp, corals and anemones). The room renovations would assist in student recruitment and retention as well since the newly renovated room would allow us to space out our currently over-crowded facility and improve the overall form and functionality of our space.

The BUMP facility houses warm and cold water tanks that are currently linked on the same water system. This results in a high-energy demand and frequent, costly repairs of the heater and chiller since they are constantly working in order to maintain both warm and cool

water. We intend to separate the warm water holding tank, thereby significantly reducing the chilling and heating requirements of the system. Maintaining separate warm and cold water holding tanks would result in a significant energy savings, a reduction in repair costs, and prevention of costly situations where one system fails.”

The estimated cost of these renovations is \$138,046. (The estimate is appended to the Biology department’s FY2012 budget request). BUMP expects to realize savings of ~\$40,000 K in our FY2011 budget (due to the price reduction we negotiated with SEA to run our Tropical Oceanography course). Assuming these funds could be redirected towards these necessary renovations, we request the additional \$98,046 that would be required to complete the renovations.

III. Teaching Fellow(s)

For the past four years, Associate Dean Scott Whitaker allocated a floating TF to BUMP, to be used where the need is greatest in a given year. In 2007, the floating TF was allocated to BI. In 2008, the floating TF was allocated to GE. In 2009 and 2010, the TF was split between ES and GE. With this single exception, all other *existing* “BUMP” courses receive TF coverage from the respective department that offers the course.

However, the development of proposed new courses that would come online in 2011 will generate additional need for TFs. “Marine Genomics” is being offered in 2010 on a provisional basis. It will serve 6-7 students. However, going forward, it will likely serve 15-20 students (or more), and it will therefore require ½ TF in 2011 and subsequent years. This course essentially replaces “Molecular Ecology,” previously taught by Barber, which required ½ TF on an annual basis, so it is expected that the TF requirements of this class could possibly be satisfied by the Biology Department. However, given high enrollments in Introductory Biology (BI107) in 2010, there would have been no TF available in Fall 2010.

The new course in “Coral Reef Dynamics” being developed for 2011 (Kaufman) would require ½ TF on an every-other-year basis.

Likewise, the proposed new course in “Coastal Nutrient Cycling” being developed for 2011 (Fulweiler) will require ½ TF in Fall 2011 and in odd-numbered years thereafter.

The chart below summarizes anticipated TF coverage for the appropriate BUMP courses for academic years 2010-11 and 2011-12. Except where a BUMP TF is indicated, the individual

departments responsible for each course should account for the course's TF requirements on their own TF allocation sheets. Underlined courses are Marine Semester (block) courses. Proposed new courses are shown bold type.

Fall, 2011

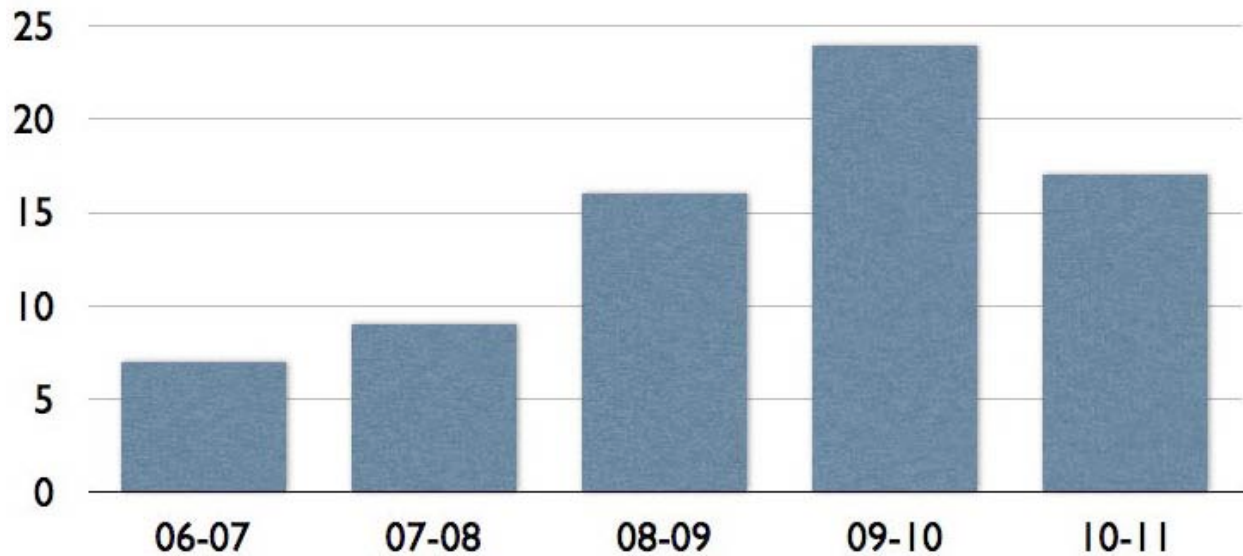
<u>Course</u>	<u>TF Needs / Source</u>
ES144, Oceanography	Supplied by ES & BUMP
<u>ES543</u> , Estuaries	Supplied by ES & BUMP
<u>ES545</u> , Caribbean I (SEA)	Not taught Fall 2011. No TF needed.
<u>ES546</u> , Caribbean II (SEA)	Not taught Fall 2011. No TF needed.
<u>ES###</u>, Coastal Nutrient Cycling (Fulweiler)	½ TF needed, (Fall 2011; alt year)
<u>GE/BI578</u> , Marine GIS	BUMP TF
<u>BI546</u> , Stellwagen/NOAA	Supplied by BI.
<u>BI547</u> , Invert. (Finnerty)	Supplied by BI.
<u>BI463</u> , Sensory Bio. (Atema)	Supplied by BI.
<u>BI531</u> , Ich. I (Lobel)	Supplied by BI.
<u>BI532</u> , Ich. II, Belize (Lobel)	<u>Two</u> , Supplied by BI.**
<u>BI/ES5xx</u>, Coral Reef Dynamics (Kaufman)	½ TF needed, (Fall 2011; alt year)
<u>BI550</u>, Marine Genomics (Finnerty)	½ TF needed, (Fall 2011; each yr.)

** Note that this is the off-campus Belize course, so there are unusual conditions encountered which precludes a strict numerical allocation.

Spring, 2012

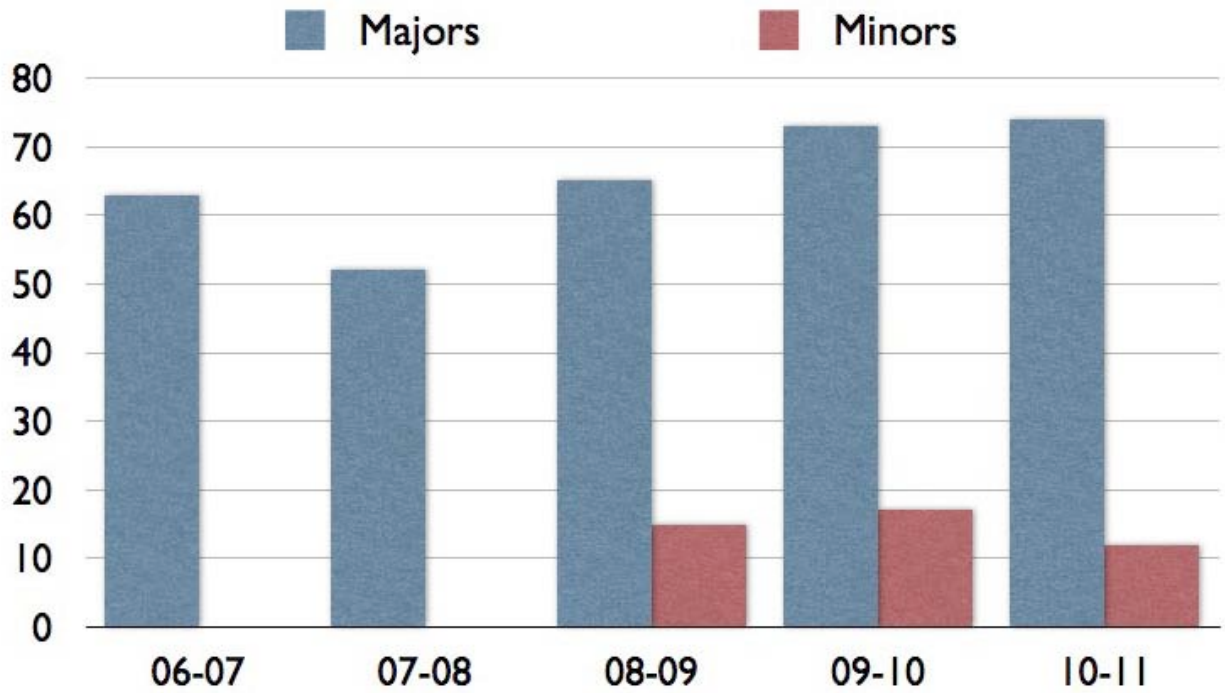
BI260, Marine Biology Two, supplied by BI.

Appendix A. Incoming Freshmen Declaring Marine Science as a Major.



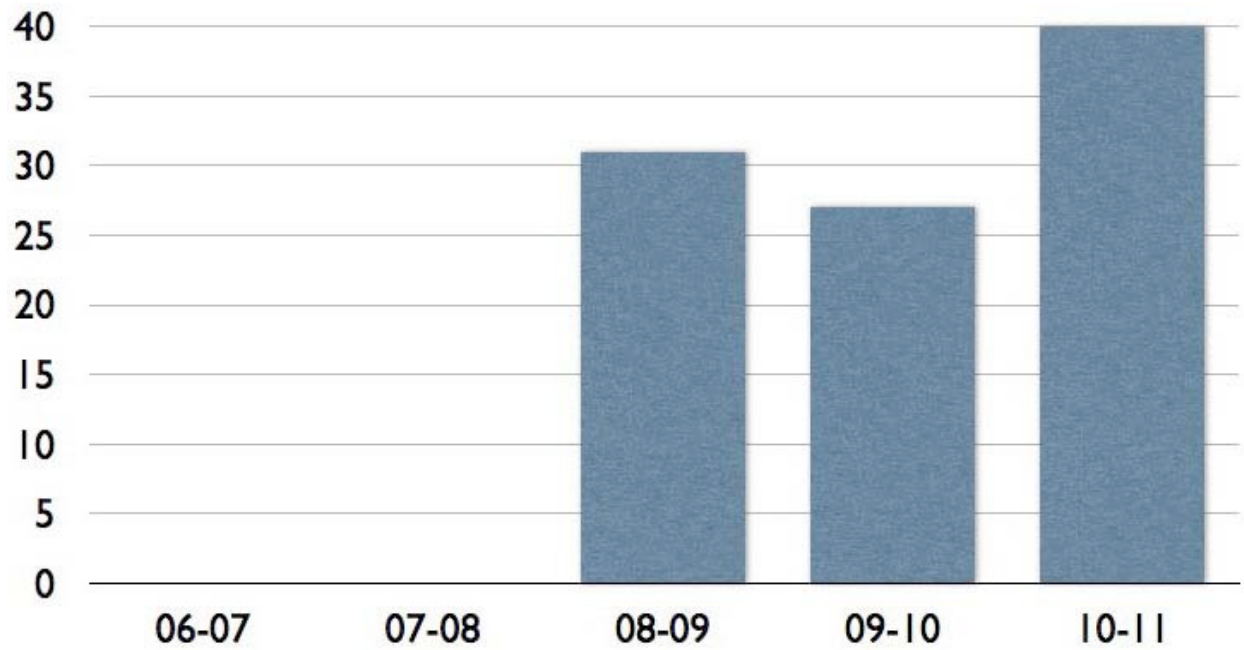
In 2006-2008, enrolling freshmen with an interest in marine studies would have declared themselves Biology majors with a specialization in Marine Science. In 2009, all of the students would have declared themselves Marine Science majors. NOTE: This chart does not include CGS and SEP (MET) freshmen on track to major in Marine Science once they enter CAS as juniors.

Appendix B. Marine Science Majors & Minors.



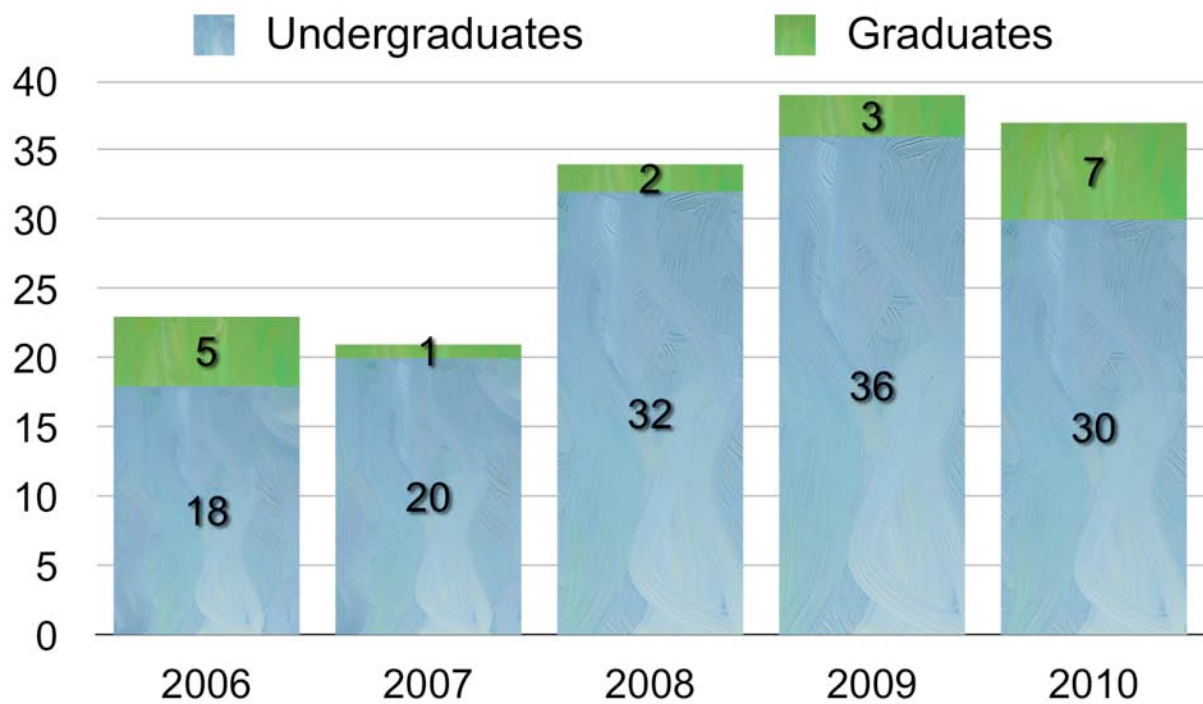
Numbers from 2006-2008 represent Biology majors specializing in Marine Science. As of 2010-2011, only Marine Science majors are shown.

Appendix C. Enrollment in the Marine Science section of Introductory Oceanography (ES144).



ES 144 is the required introductory course in oceanography for Marine Science majors. Students who identify themselves as Marine Science majors enroll in the MP section.

Appendix D. Enrollments in the Marine Semester (2006-2010).



The total number of students who registered for at least 1 course in the Marine Semester is shown.

Appendix E. Essential content areas of a modern marine science curriculum.

Content Area	Current or Planned Courses Offering Significant Coverage
Climate / Global Change	BI/ES ### "Coral Reef Dynamics" [beginning 2011]
Conservation / Fisheries	BI531/532 "Ichthyology" BI546 "Marine Megafauna" BI/GE 578 "Marine GIS" ES 545/546 "Tropical Oceanography" [ending 2010] BI/ES ### "Coral Reef Dynamics" [beginning 2011]
Ecology	BI531/532 "Ichthyology" BI546 "Marine Megafauna" BI547 "Marine Invertebrates" BI563 "Sensory Biology" BI/GE 578 "Marine GIS"
Environ. Contam. / Pollution	BI/ES ### "Coral Reef Dynamics" [beginning 2011] ES ### "Coastal Nutrient Cycling" [beginning 2011]
Evolution	BI531/532 "Ichthyology" BI546 "Marine Megafauna" BI547 "Marine Invertebrates" BI563 "Sensory Biology"
Fluid Dynamics	BI563 "Sensory Biology" ES543 "Estuaries and Near-shore Systems"
Genetics / Genomics	BI550 "Marine Genomics" [beginning 2010]
Geochemistry / Nutrient Cycling	BI/ES ### "Coral Reef Dynamics" [beginning 2011] ES ### "Coastal Nutrient Cycling" [beginning 2011]
Geography / Spatial Analysis	BI/GE 578 "Marine GIS"
Geology / Geomorphology	ES543 "Estuaries and Near-shore Systems" ES 545/546 "Tropical Oceanography" [ending 2010]
Molecular Biology	BI550 "Marine Genomics" [beginning 2010]
Organismal Biol. (anatomy, physiology, behavior)	BI531/532 "Ichthyology" BI546 "Marine Megafauna" BI547 "Marine Invertebrates" BI563 "Sensory Biology"
Physical Oceanography	BI546 "Marine Megafauna" BI/GE 578 "Marine GIS" ES 545/546 "Tropical Oceanography" [ending 2010]
Policy	BI546 "Marine Megafauna" ES 545/546 "Tropical Oceanography" [ending 2010]

Appendix F. Taxonomic coverage of Marine Semester courses.

Biological Taxon	Current or Planned Courses Offering Significant Coverage
Vertebrates	
Humans	BI546 "Marine Megafauna" ES 545/546 "Tropical Oceanography" [ending 2010] BI/ES ### "Coral Reef Dynamics" [beginning 2011] ES ### "Coastal Nutrient Cycling" [beginning 2011]
Fishes (bony & cartilaginous)	BI531/532 "Ichthyology" BI563 "Sensory Biology"
Marine / Shore Birds	BI546 "Marine Megafauna"
Marine Mammals	BI546 "Marine Megafauna"
Invertebrates	ES 545/546 "Tropical Oceanography" [ending 2010] BI547 "Marine Invertebrates" BI563 "Sensory Biology" BI/ES ### "Coral Reef Dynamics" [beginning 2011]
Microbes	BI/ES ### "Coral Reef Dynamics" [beginning 2011] ES ### "Coastal Nutrient Cycling" [beginning 2011]
Plankton	ES 545/546 "Tropical Oceanography" [ending 2010]
Plants	ES543 "Estuaries and Near-shore Systems"

Appendix G. Marine environments surveyed in the Marine Semester

Environment	Current or Planned Courses Offering Significant Coverage
New England	
Coastal Waters	BI531/532 "Ichthyology" BI546 "Marine Megafauna" ES543 "Estuaries and Near-shore Systems" ES ### "Coastal Nutrient Cycling" [beginning 2011]
Estuaries	BI547 "Marine Invertebrates" BI563 "Sensory Biology" ES543 "Estuaries and Near-shore Systems" ES ### "Coastal Nutrient Cycling" [beginning 2011]
Urban Environs	BI547 "Marine Invertebrates" [in 2010 +, a greater focus on Boston field sites]
Tropics	
Coral Reef	BI531/532 "Ichthyology" BI/ES ### "Coral Reef Dynamics" [beginning 2011] ES ### "Coastal Nutrient Cycling" [beginning 2011]
Open Ocean	ES 545/546 "Tropical Oceanography" [ending 2010]
Research Platform	
Ship / Boat	BI531/532 "Ichthyology" ES543 "Estuaries and Near-shore Systems" ES 545/546 "Tropical Oceanography" [ending 2010]
Diving / Snorkeling	BI531/532 "Ichthyology"
Wading	BI547 "Marine Invertebrates" ES543 "Estuaries and Near-shore Systems"

Appendix H. Skills taught in the Marine Semester

Skill	Current or Planned Courses Offering Significant Coverage
Animal Culture / Monitoring	BI547 "Marine Invertebrates" BI563 "Sensory Biology"
Boat Operation & Safety	BI531/532 "Ichthyology"
Diving / Snorkeling	BI531/532 "Ichthyology" [cannot provide diving certification]
Environmental Sampling	BI546 "Marine Megafauna" BI547 "Marine Invertebrates" ES543 "Estuaries and Near-shore Systems" ES545/546;
First Aid	BI531/532 "Ichthyology" ES545/546
Fluid Dynamics	BI547 "Marine Invertebrates" ES543 "Estuaries and Near-shore Systems"
GIS / GPS	BI/GE578
Microscopy	BI547 "Marine Invertebrates"
Molecular Biology	BI550 "Marine Ecological Genomics" [beginning in 2010]
Phylogenetic Analysis	BI531/532 "Ichthyology" BI547 "Marine Invertebrates"
Species Identification	BI531/532 "Ichthyology" BI546 "Marine Megafauna" BI547 "Marine Invertebrates" ES546
Seamanship / Navigation	ES545/546;
Scientific Presentation	All marine semester courses
Stable Isotope Analysis	BI546 "Marine Megafauna"
Statistical Analysis	All marine semester courses