

# ENVIRONMENTAL CONSERVATION – THE GRADUATE EXPERIENCE

## EXECUTIVE SUMMARY

### **Our Vision and ECo's Three BIG IDEAS**

In the Department of Environmental Conservation (ECo), we are launching initiatives to move forward three BIG IDEAS that capitalize on: a) academic programming and coordination, and b) expanding opportunities for MS & PhD research and one-year professional master's degree programs.

- Initiative 1:** Develop a new inter-departmental graduate program in Ecology, Environmental Conservation & Sustainability, including an integrated professional master's degree program focused on career development.
- Initiative 2:** Establish a *Center for Environmental Governance & Decision-Making* to expand our visibility and capacity to conduct research and train graduate students by working with on-campus partners, in particular collaborating faculty in the newly proposed School of Public Policy.
- Initiative 3:** Launch a cooperative regional research effort, *Headwaters to Oceans (H2O)* to expand our graduate research and teaching in aquatic biology, ecology and ecosystem science while enhancing our capacity at the UMass Gloucester Marine Station and the Cronin National Fish Hatchery.

### **Our Key Strengths & What We do Best**

Our ECo community recognizes the interconnectedness of our research, our graduate students, and our success and reputation in the field. Currently, ECo has 35 faculty members with active research programs, including tenure-track, extension, and jointly-appointed faculty. In the past four years, ECo faculty trained over 260, and currently advise 124, graduate students. Within ECo, we have one departmental graduate program that offers graduate students the opportunity to pursue either a research (MS thesis, PhD) or professional degree (MS non-thesis). Additionally, many ECo faculty also participate in one or more interdisciplinary graduate programs (e.g., Organismic and Evolutionary Biology, Plant Biology, Public Policy and Administration, Intercampus Marine Science Graduate Program, and the Sustainability Science Program). Adjunct faculty are also critically important to the success of our graduate program, and include at least 10 PhD research scientists from federal agencies that are co-located on campus or nearby and serve as major advisors for ~30% of the graduate students in ECo's MS/PhD research graduate program.

The mix of PhD and MS students fuel the progress and success of our research program. Our students are highly productive, serving as either senior or junior authors with over 200 peer-reviewed publications over the past four years. Further, job placement for our ECo graduates, including masters professional and research and PhD students, is extraordinarily high across a wide diversity of organizations. Virtually all of our MS and PhD graduates find employment in their field after graduation.

In recent years, our faculty have greatly expanded their participation in large competitive and sponsored research programs. Senior and early career faculty will continue their efforts to expand these funding opportunities, while continuing their commitment to meeting the research needs of our state and federal resource management agencies, NGOs, and industry partners via research contracts. Although many of these research contracts are typically smaller grants with reduced indirect costs, we are committed to providing this research as part of our mission as a public land-grant institution. Further, we believe that the implementation of **Our Three Big Ideas**, will greatly expand opportunities for ECo faculty to obtain large, competitive, multidisciplinary grants.

### **Areas of Emphasis & Emerging Areas of Research**

ECo is a forward-moving department seeking to meet the research needs of the Commonwealth and our primary stakeholders – state and federal agencies, NGOs, and private industry. However, we are also engaged in multi-disciplinary research programs, including competitive grants from NSF, DOD, and USDA. Nearly all ECo faculty engage in outreach activities as a natural outgrowth of their research, and we are committed to focusing our research to solve the many challenges of environmental sustainability. Consequently, the applied nature of much of the ECo research lends itself well to extension applications and tech transfer. Six areas of emphasis characterize the department's current research program and provide focus for areas for future investment.

- *Climate and Conservation Science*
- *Ecology and Conservation of Plant and Animal Populations*
- *Ecology and Conservation of Landscapes, Watersheds, and Estuarine Ecosystems*
- *Effects of Urbanization on Natural Resource Conservation*
- *Environmental Governance and Decision-Making*
- *Building Systems*

### **Internal Reallocation**

We continue to:

- Realign faculty in new directions to a) take advantage of emerging research areas, b) expand opportunities for interdisciplinary research, and c) better align faculty in areas with the strongest potential for extramural funding.
- Shift some faculty positions into lecturer positions rather than tenure-track positions in areas that have less potential for extramural funding, but a high potential for enhancing graduate education and expanding professional master's degrees.

### **Potential for Fee-Paying Master's Programs**

We plan to:

- Create a substantial revenue stream for ECo via a 1-year professional Master's degree in Environmental Sustainability (MES) as part of a new Inter-departmental Graduate Program in Ecology, Environmental Conservation & Sustainability
- Strongly encourage modification the university's policy on tuition return to departments for fee-paying master's programs to provide departments suitable resources and incentives for developing and offering these programs

### **Promotion and Flexible Faculty Appointments**

We continue to:

- Adjust faculty appointments annually to help faculty meet their professional and promotion goals and to maximize their productivity for the year.
- Establish a strong tradition of mentoring early career faculty, making sure they are on track for successful tenure and promotion outcomes.
- Coordinate efforts of DPC and DH to track and encourage associate professor faculty for promotion to full professor rank.

### ***Increased Pursuit of Sponsored Research Opportunities***

We continue to:

- Expand these funding opportunities by participation in large competitive, multidisciplinary grants and sponsored research programs.
- Our commitment to meeting the research needs of our state and federal resource management agencies, NGOs, and industry partners via research contracts, as part of our mission as a public land-grant institution.
- Fund a substantial proportion of our research enterprise by research contracts from state and federal resource management agencies, often via cooperative agreements with reduced overhead.
- *We believe these cooperative agreements are an integral part of our research program, despite their reduced overhead, and provide important public service of our land-grant mission.*

### **Our Highest Priorities for Improving Our Doctoral Program**

We plan to:

- Shift to a more flexible admissions policy, allowing highly qualified students to enter directly into a PhD program instead of the current policy that requires all entering PhD students to have completed a MS.
- Develop a more stable and equitable source of salary support, possibly using a strategy of combined “guaranteed” TA support in conjunction with RA support from research grants.
- Hire a graduate program manager to be the “go-to” contact for all new and continuing students regarding the logistics of the program, questions and problems that arise and a critical “non-faculty” source of advice on how to succeed in the program.
- Institute an annual ECo Graduate Student-Faculty Retreat featuring a symposium-style series of graduate student and faculty research featuring a symposium-style series of graduate student and faculty research talks, break-out discussions for groups working in related and complementary fields, and ample social & recreational opportunities for students and faculty to interact.
- Provide a consolidated physical space for graduate students that includes offices, a conference room, and a social meeting/lunch space.
- Expand opportunities to develop better communication and technical/research skills

### **Why Are Our MS Degrees So Important**

#### ***Benefits To the Students***

- The MS degree in Environmental Conservation is a critical credential needed for students to gain professional employment, especially local, state and federal government agencies; NGOs; and business/industry/consulting firms. Since 2010, 84% of 43 ECo MS research grads, and 97% of 29 ECo’s professional MS degree graduates work in these non-academic positions.

- External research grants support the majority of MS research degree students
- An essential part of graduate student funding comes from tuition and fee waivers. With the exception of URI, we know of no peer-institution programs in the same field as ours that does not offer tuition and fee waivers for MS research students. We could not compete for qualified students without them.
- There is a clear consensus among current MS students in our program that they would not have come to our program, and could not continue in the program, if such waivers were eliminated. There is no cost accrual, much less savings, to the University if waivers were eliminated.
- *We believe that tuition waivers for MS students in ECo are one of the best investments that the University ever makes in terms of providing support to deserving students who will make significant impacts in their chosen field, most especially for international students from less-developed countries around the world.*

#### *Benefits To the University*

- Recent graduates (since 2010) and current ECo MS students have been lead or co-authors on 66 peer-reviewed publications (vs. 128 for PhD students), nearly all of which were co-authored by their mentoring faculty member. This matches the expectations of the funding sources for these students who are addressing conservation questions posed by state agencies, federal agencies, and NGOs that expect answers in a timely and efficient manner.
- The relatively rapid development and publication of new knowledge by MS students contributes greatly to the research programs of faculty, especially early career faculty in promotion and tenure.
- Professional MS degree programs provide an important stream of revenue for the department and college, and funds generated exceed the cost of operation. These degree programs are also highly attractive to prospective students, including undergraduates looking for an additional year of educational training and mid-career professionals.
- To be successful, MS professional degree programs must offer training in very specific fields (rather than a general field offered by nearly all other graduate programs in our field), and in fields for which there are clear employment opportunities for the future.

#### *Benefits To the Commonwealth, the Nation, and the World*

- Land-grant universities such as ours were established as places offering "public education for public purpose" (UMass Amherst Sec. Doc. No. 93-021) to "**benefit the people in Massachusetts, the nation, and the world**" (cf. Trustee Document T05-024).
- Our MS programs are an essential component of this mission because our training is tied directly to agencies and organizations that employ our graduates.
- Our MS students carry out essential research to answer important conservation questions for the Commonwealth, several federal agencies, and NGOs.
- Our international students become the conservation leaders in their countries upon returning home.
- We play a pivotal role in fulfilling the university's promise of "**embracing responsibility for the sustainability of the planet, for the progress of society, and for the development of each individual**".

# ENVIRONMENTAL CONSERVATION – THE GRADUATE EXPERIENCE

## Strategic Planning Process: Our Approach

The Department of Environmental Conservation (ECo) embraced the strategic planning process as an opportunity to come together and identify what works and what needs improvement within our department relative to our research and graduate education. This process involved reviewing the Academic Analytics data, collecting input and survey data from faculty and graduate students, contacting peer institutions, and synthesizing the information into this summary document. We utilized a combination of large group discussions and the input from three faculty-led teams. The end result is a document that is responsive to the review guidelines, and reflective of our collaborative approach and collective perspective and aspirations for our department's research and graduate education. For ECo, we intend to use this document in concert with our recent (2013) AQAD vision document as a road map for how we can refine our graduate programs and incorporate best practices.

In this summary, we highlight why UMass Amherst and ECo, in particular, are poised to be: a) a world-recognized center for research, teaching, innovation, and problem-solving in ecology, environmental conservation and sustainability, and b) the destination of choice for prospective graduate students who will become the next generation of environmental leaders prepared to address the complex, global challenges of environmental sustainability. The following topics are presented in our summary:

- **Three Big Ideas** that ECo is pursuing in concert with on- and off-campus partners;
- **Key strengths** that distinguish ECo, providing our students with effective graduate training and high-quality educational experiences; and
- **Areas of improvement** to strengthen and increase the attractiveness and effectiveness of our graduate programs.

For this report, ECo combines our graduate program in Environmental Conservation (ECo) and the inter-departmental professional master's degree program in Sustainability Science offered by the College of Natural Sciences (CNS), which is primarily administered by ECo.

## PART 1.1: OUR VISION AND ECO'S THREE BIG IDEAS

We are launching initiatives to move forward three BIG IDEAS that capitalize on: a) academic programming and coordination, and b) expanding opportunities for MS & PhD research and 5<sup>th</sup> year professional master's degree programs.

**Initiative 1:** **Develop a new inter-departmental graduate program in Ecology, Environmental Conservation & Sustainability, including an integrated professional master's degree program focused on career development.**

**Rationale:** Our current ECo graduate program contains an exceptionally diverse mixture of students with vastly different national origins, academic backgrounds (ranging from the social sciences to the natural sciences), career interests (ranging from professional practice in agencies, NGOs and industry to science careers in agencies and academia), and disciplinary interests (ranging

from single discipline interests such as wildlife ecology, water conservation and building systems to interdisciplinary interests such as sustainability, climate change, human dimensions and systems thinking). Owing to this diversity, structuring our graduate program to better meet these diverse needs is an ever-present challenge. In particular, there is a growing difference between the needs and expectations of our MS thesis degree students and the professional master's degree students. Additionally, colleagues in the Stockbridge School of Agriculture and Geosciences have expressed a need for an inter-departmental graduate program to train some of their graduate students in areas of environmental sustainability and a variety of other professional master's degree concentrations.

With these considerations in mind, ECo identified the creation of an inter-departmental graduate program in **Ecology, Environmental Conservation & Sustainability** as a priority initiative that would help address our needs, improve the quality of our graduate education, and provide the framework to:

- Increase program effectiveness and student engagement
- Maximize attractiveness to prospective students
- Create cohesion for graduate training within our department and across departments
- Improve our administrative coordination to expand existing interdisciplinary programs and develop new ones
- Increase our revenue stream through the expansion of 1-year professional master's degree programs

The inter-departmental nature of the program serves to broaden faculty involvement, adding faculty from the Stockbridge School of Agriculture and Geosciences, and potentially expanding to also include faculty from other UMass departments and the 5 Colleges. The proposed reorganization also provides a more clear distinction between the thesis and professional (non-thesis) master's degrees, as is appropriate. The one-year professional degree is a shorter and more focused graduation program where students are responsible for tuition and fees. The financial cost and timeline to entering the workforce are two major incentives of this program compared to our current 2-year or more long program.

### Description

The program would be established within the College of Natural Sciences (CNS) to serve as the central hub for graduate programs in **ecology, environmental conservation, and sustainability**. To achieve this, we propose to modify the following two existing ECo graduate programs, with one focused on **MS and PhD research**, and the second focused on a **1-year professional master's degree program** (each program with a Graduate Program Director).

- 1) *Environmental Conservation* – will focus only on MS and PhD **research** degrees. It will involve reorganizing the current ECo graduate program from a departmental into an inter-departmental program, and expanding it to include new concentrations, offering specializations in one of several concentrations (Appendix 1). The MS degree is intended for students interested in a career in science and/or the pursuit of a PhD, and will require a minimum of 2.5 years to complete. Most importantly, the MS degree will include the requirement of a rigorous thesis research project, publishable scientific papers, and a defense. Students in this program will offset the costs of their education through a variety of funding opportunities, including TAs, RAs, fellowships, and externships. Consequently, the professional/non-thesis MS degree

concentrations currently offered in the existing ECo graduate program will be modified and shifted into a new MES program (see below).

- 2) *Professional Master in Environmental Sustainability (MES)* – will be a one-year professional master’s program designed for students seeking a professional career in environmental conservation and sustainability. It will involve reorganizing the existing inter-departmental professional (non-thesis) degree program in Sustainability Science, and rename its degree to a Master of Environmental Sustainability (MES), with students specializing in one of several concentrations (Appendix 1). The MES program is designed to be a condensed program of study, self-funded, and intended as a terminal degree that provides students the advanced study needed to be competitive in the job market and expand professional credentials. Concentrations are structured around only those specialties that support high job placement. The professional MS degree concentrations currently offered in the existing ECo graduate program will be modified and shifted into this new MES program. Similarly, several of the concentrations in the existing professional MS degree in Sustainability Science will be modified and incorporated into this new MES program.

**Initiative 2: Establish a *Center for Environmental Governance & Decision-Making* to expand our visibility and capacity to conduct research and train graduate students by working with on-campus partners, in particular collaborating faculty in the newly proposed School of Public Policy.**

**Rationale:**

Solutions to the “wicked environmental problems” encountered around the globe today will require knowledge of the complex and interconnected relationships that structure how humans respond to and influence the environment, including the institutions and processes facilitating or inhibiting human actions. Increasing connectivity between ECo and the School for Public Policy will foment interdisciplinary research and education on the interactions between policy, governance and the environment, bringing UMass to the fore as a leader in integrated research on the environment. These collaborations will build upon ECo’s existing strengths in social science and will bring to the proposed School of Public Policy the environmental expertise needed to address key concerns of today, including global environmental change. Specific goals include increasing cross campus research on the environment, expanding pathways for interdisciplinary training of students, and coordinating engagement with stakeholders, including federal, state, and local policy-makers.

**Initiative 3: Launch a cooperative regional research effort, *Headwaters to Oceans (H2O)* to expand our graduate research and teaching in aquatic biology, ecology and ecosystem science while enhancing our capacity at the UMass Gloucester Marine Station and the Cronin National Fish Hatchery.**

**Rationale:**

Good conservation decisions depend on good science. To better protect our water and aquatic resources, we need a greater understanding of how serious threats—from overfishing to climate change—are altering aquatic ecosystems from headwater streams to the ocean. These changes will have profound effects on aquatic and terrestrial ecosystems across the region, affecting the structure

of fish and wildlife communities, agriculture, water allocations, energy, and our human communities in coastal and inland communities alike.

We envision a multi-agency collaborative linking our UMass Gloucester Marine Station and the Cronin National Fish Hatchery to provide hands-on opportunities for experimental and field-based research for students in marine, estuarine and freshwater ecology, conservation biology, fish biology, and sustainability. Consistent with our overall H2O vision, Gloucester represents a critical infrastructure and physical presence in a region with a rich maritime history. Similarly, the Cronin Hatchery provides the infrastructure - ponds, raceways and surrounding forest - with capacity for small to large-scale experimental manipulations, and high quality flowing water with extensive fish rearing facilities used in the past as part of the Connecticut River Atlantic salmon program. These facilities provide the infrastructure critical for cutting-edge teaching and research in aquatic ecology and fisheries, and collaborative hubs that would allow accelerated development of research partnerships.

At the request of the chancellor and provost, an ECo team has developed proposals to enhance teaching, research, and outreach opportunities to support our H2O vision. Additionally, ECo has recently received a \$2+ mill bequest from Lawrence and Alice Shepard to fund graduate research in the most pressing environmental challenges affecting freshwater and marine ecosystems. Once fully realized, this endowment will play an important role in supporting graduate students as a part of our Headwaters to Ocean (H2O) initiative.

## Who We Are

We, in the Department of Environmental Conservation (ECo), are passionate about our mission - *the stewardship of healthy and sustainable ecosystems that provide important human and community benefits* – and about making a BIG difference in the world. By virtue of this mission, our breadth of expertise, and our inherent ability to reach across disciplines, ECo is uniquely qualified and deeply committed to training the next generation of scholars and practitioners able to solve the complex, global challenges of environmental sustainability. We also play a pivotal role in fulfilling the university’s promise of *“embracing responsibility for the sustainability of the planet, for the progress of society, and for the development of each individual”*.

Our ECo community recognizes the interconnectedness of our research, our graduate students, and our reputation in the field. Currently, ECo has 35 faculty members with active research programs, including tenure-track, extension, and jointly-appointed faculty. In the past four years, ECo faculty trained over 260 graduate students, and we currently advise 124 graduate students (Table 1). Many ECo faculty also participate in one or more interdisciplinary graduate programs, including [Organismic and Evolutionary Biology](#), [Plant Biology](#), [Public Policy and Administration](#), [Intercampus Marine Science Graduate Program](#), and the [Sustainability Science Program](#), so it is possible for graduate students and postdocs to work with an ECo professor as their major advisor while studying in these interdisciplinary programs (Fig. 1).

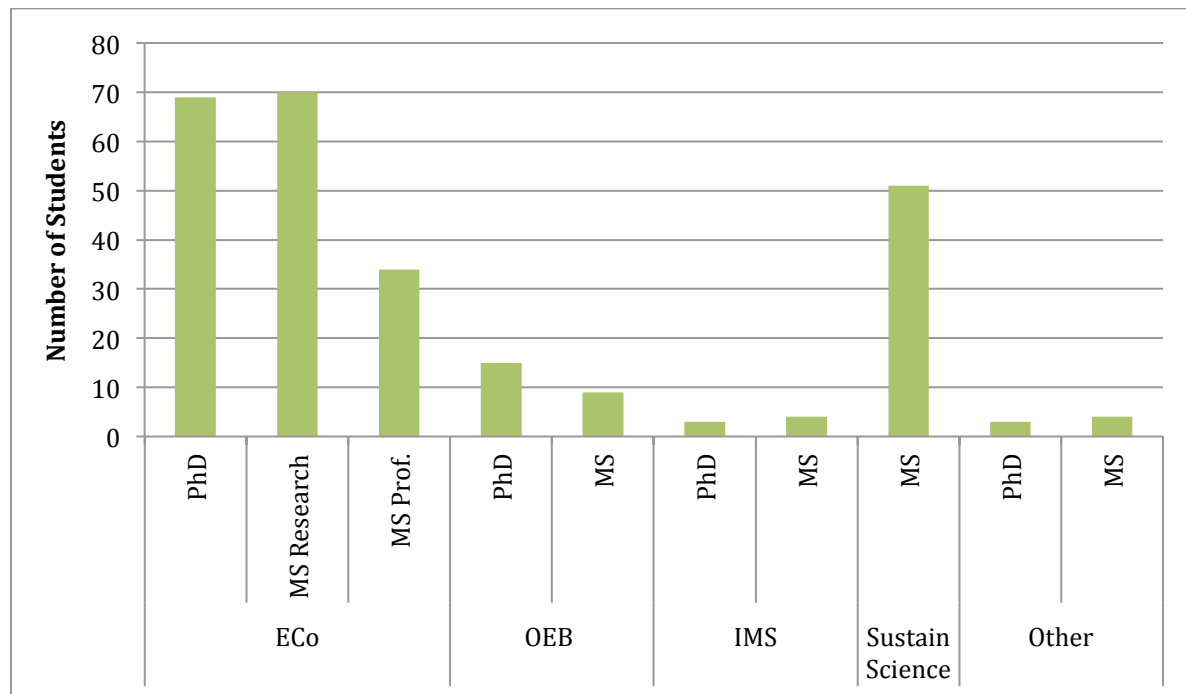
Table 1. Numbers of graduate students (MS & PhD) advised by ECo faculty by graduate program, 2010-2014.

	No. of Students	Percent
Environmental Conservation	173	66%
Organismic & Evolutionary Biology (OEB)	24	9%
Intercampus Marine Science (IMS)	7	3%



Sustainability Science	51	19%
Other (including Entomology and Economics)	7	3%
TOTAL	262	

Fig. 1. Numbers of graduate students advised by ECo faculty by program, 2010-2014.



Adjunct faculty are also critically important to the success of our graduate program, and include at least 10 PhD research scientists from federal agencies that are co-located on campus or nearby, including: the U.S. Geological Survey MA Cooperative Fish and Wildlife Research Unit, U.S. Forest Service Center for Research on Ecosystem Change, U.S. Fish & Wildlife Service Northeast Regional Office, and the U.S. Geological Survey Conte Anadromous Fish Research Center. The contributions of these adjunct faculty to our graduate program are enormous, serving as major advisors for upwards 30% of the graduate students in ECo's MS/PhD research graduate program.

The mix of PhD and MS students fuel the progress and success of our research program. Further, our students are very productive, serving as either senior or junior authors on over 207 peer-reviewed publications over the past four years (Fig. 2). Further, job placement for our Eco graduates, including Masters professional and research and PhD students is extraordinarily high across a wide diversity of organizations (Fig. 3). Virtually all of our MS and PhD graduates find employment in their field after graduation.

Fig. 2. Numbers of senior- and junior-authored publications by graduate students advised by ECo faculty in peer-reviewed journals by graduate program, 2010-2014.

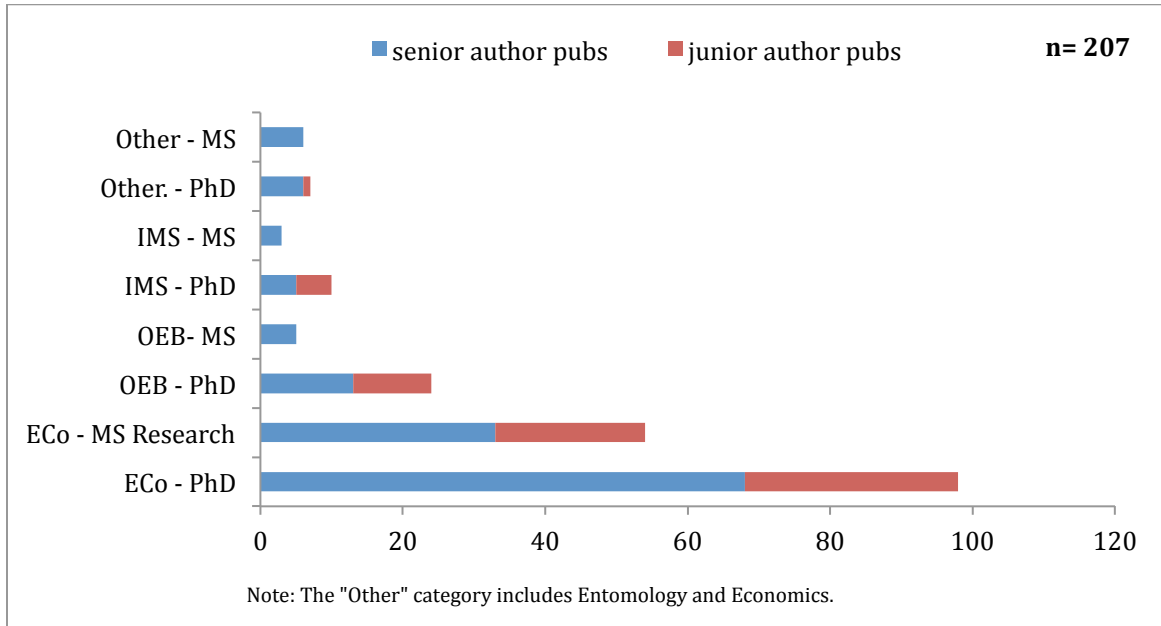
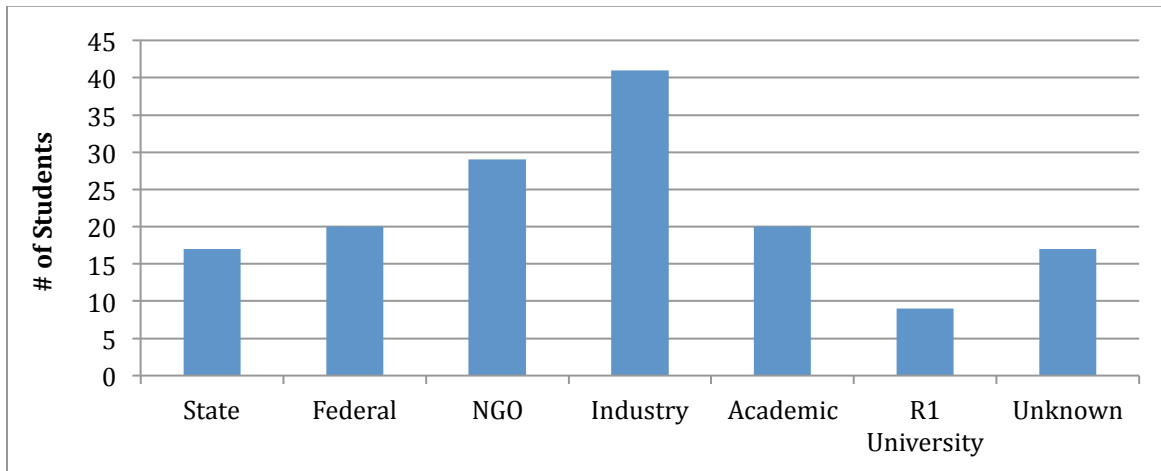


Fig. 3. Career placement of graduate students (MS & PhD) advised by ECo faculty, 2010-2014.



### What We do Best: Areas of Emphasis & Emerging Areas of Research

ECo is a forward-moving department, building on our strengths and adapting to meet the research needs of the Commonwealth and our primary stakeholders – state and federal agencies, NGOs, and private industry. However, we are also engaged in multi-disciplinary research programs, including competitive grants from NSF, DOD, and USDA. Six areas of emphasis characterize the department's current research program and provide focus for areas for future investment.

### *Climate and Conservation Science*

Climate change is already affecting the physical and biological environments of the NE Region, and is expected to intensify in coming decades. All of these changes will have profound effects on aquatic and terrestrial ecosystems across the region, changing terrestrial and aquatic environments, affecting the structure fish and wildlife communities and the timing of migratory fishes and birds. Understanding how climate affects habitats and other conditions for fish and wildlife populations will be essential for decision-makers challenged with balancing multiple land uses, including agriculture, forestry, water allocations, energy, and transportation. These changes will also affect our human communities in coastal and inland communities alike, especially from the effects of sea level rise and greater frequency of extreme events.

ECo is well known for its leadership in understanding effects of climate change on fish and wildlife resources, aquatic and terrestrial systems, and ecosystem services. We are pioneering new analytical tools for landscape scale analyses of climate change effects; and partnering with state and federal resource management agencies, NGOs and international organizations to meet their information needs and provide science support tools for developing climate adaptation and mitigation strategies for ecosystems and human communities. In addition, two ECo faculty are Co-PIs on the \$7.5 million Department of Interior grant for the NE Climate Science Center, and several ECo faculty conduct research in collaboration and with support from the NE CSC. Further, ECo faculty have strong relationships with many of the DOI management agencies in the region, particularly with Region 5 of the U.S. Fish and Wildlife Service whose regional headquarters is five minutes from campus. Similarly, ECo faculty are major science partners with the DOI Landscape Conservation Cooperatives with multiple collaborative projects underway across the Northeast and Mid-Atlantic regions. ECo also has extensive and long-standing relationships with state and federal natural resource management agencies and NGOs throughout the region with many federal agency scientists housed on or close to campus.

### *Ecology and Conservation of Plant and Animal Populations*

Specific plant and animal populations are the focus of management when: 1) populations are quite small, especially when species are legally listed as rare, threatened, or endangered; 2) species are important for their commercial or cultural value; 3) species (often not native to the region) act as pest or disease organisms or invade and displace native species, and 4) climate and landscape change will likely have important effects on biotic communities. Much management of animal populations is carried out through modification of their habitats. Well-developed management plans must be based on sound basic knowledge regarding the population ecology of the species being managed and on an understanding of the social and economic impacts of these management actions on local stakeholders and the general public.

ECo is well known for its leadership in the areas of population ecology, life history characteristics, and behavior of species that are rare, or have grown in numbers to the extent of becoming problem species; social and policy analysis of hunting, trapping, and fishing; ecology and control of invasive plant species; ecological restoration of habitats or populations of rare species, and effects of renewable energy. Two ECo faculty are Co-PIs on the \$3.2 mill NSF IGERT grant in Offshore Wind Energy, and several additional ECo faculty conduct research and train doctoral students in collaboration and with support from this IGERT Program. Similarly, one ECo faculty is PI on a \$1.7 mill DOD grant focused on restoration of soil microbial function and biological invasions.

### *Ecology and Conservation of Landscapes, Watersheds, and Estuarine Ecosystems*

Sustainable management of forest, freshwater, and estuarine ecosystems (all of which are interconnected at the regional scale) is critical to sustaining human and ecological health. Agricultural land abandonment in Massachusetts over the past 150 years has led to recovery of forestland (now covering 70% of the state, from a low of 30% in 1850). Forest recovery has led to natural or managed reintroductions of black bears, moose, bald eagles, and fishers—species typically associated with large wilderness areas. The forest land-base is largely privately owned, mostly with recreation and conservation as the primary purposes of ownership; however, income from timber management is still quite important to allow owners to maintain their lands in an undeveloped condition. Watershed management is one of the most important regional concerns, with more than 35 million people in towns and cities throughout the Northeastern U.S. depending upon water from municipal reservoirs in forested watersheds. Coastal areas are also the focus of intense interest because of the combination of high human population density, coastal hazards, commercial and recreational fisheries, and important wildlife habitat areas.

ECo has considerable strength in such areas as forest and watershed management, landscape and aquatic ecology, geographic information systems, wildlife and fisheries management, wetlands science, policy analysis of land use and ownership, and social impacts of government agency programs—all contributing to interdisciplinary research on resource conservation at large geographical scales. Two ECo faculty are PI/Co-PIs on grants totaling \$1.7 mill from state and federal agencies integrating research and extension initiatives focused on river & stream continuity and flood hazard mitigation. Similarly, one ECo faculty is PI on grants totaling in excess of \$1.2 mill from the U.S. Fish & Wildlife Service focused on landscape-scale biodiversity conservation planning with climate and landscape change. Another ECo faculty is PI for a \$500k grant on a multi-state National Institute of Food and Agriculture for family forest landowner decision-making.

### *Effects of Urbanization on Natural Resource Conservation*

One of the rapidly developing areas in conservation science deals with the effects of urban and suburban expansion on ecosystems. The central issue is to determine how to provide for human habitation and commerce while minimizing impacts on biodiversity, water supply, climate, outdoor recreation, landscape aesthetics, and overall quality of life. Massachusetts is an excellent place to study ecology and resource management along an urban-suburban-rural gradient, with the strong shift in human population density from the Boston metropolitan area to the rural Berkshires. In Massachusetts, the management objectives for public and private lands, and water resources can be described as: creating ecologically healthy, livable urban centers; preserving the rural character of suburban areas; and maintaining rural landscapes and economies in the forest-and-farm region. Research focused on these objectives is clearly important for solving problems in the Commonwealth by creating new approaches for environmental conservation, smart growth, and land-use planning.

Wildlife and fisheries faculty provide ECo with a long-standing strength in this research area involving urban impacts on terrestrial and aquatic systems. Similarly, the building and construction technology group study green building design and energy efficient housing, while our arboriculture and urban forestry faculty provide ECo with a long-standing strength in the management of urban trees for diverse benefits to our communities. ECo's social scientists provide expertise in environmental governance and decision-making, providing a logical link with the Landscape Architecture and Regional Planning department, and Center for Public Policy & Administration. One ECo faculty collaborates as Co-PI on several NSF funded urban ecology projects, including LTER and ULTRA-Ex projects. Similarly, another ECo faculty is a Co-PI on the \$6 mill DOER

grant for the MA Energy Efficiency Initiative, and several ECo faculty conduct extension, research and train graduate students and postdocs in collaboration and with support from this initiative.

### *Environmental Governance and Decision-Making*

ECo is well-regarded as a hub of knowledge on environmental conservation and sustainability. In addition to strengths in the ecological aspects of conservation and in green building, we address the interface between people, the built environment, and ecosystems. Through our research and teaching, we address the “human dimensions” of environmental conservation and have sought to understand how people and policy influence conservation outcomes, what motivates people in their environmentally-related actions (such as land conservation), how conflict is dealt with, and what kinds of policies, decision-making and institutions lead to (or inhibit) effective conservation. Whether the focus is on fish, water, plants, forests, wildlife, urban ecosystems, or even broader issues such as climate change or sustainability science – human behavior (values, conflicts, engagement) and environmental governance and institutions (policy, law, regulation, decision-making), play an important role in the environmental outcome.

With the USDA’s National Center for Family Forestry at UMass, ECo is also internationally known for its research that helps understand the social and economic dimensions of family forestry in order to promote sustainable forest management that meets the current and future needs of landowners, communities, and society. Further, with the recent addition of two new faculty with expertise in Environmental Governance & Decision-Making, and the joint faculty member we already shared with the Center for Public Policy & Administration, we now have a core subgroup with the capacity to expand research opportunities working collaboratively with faculty both within and outside of ECo. Leveraging this expertise with faculty in other departments via a new Center for Environmental Governance & Decision-Making (**Big Idea #2**) as a part of a new School of Public Policy will greatly expand our capacity for multidisciplinary research and community engagement that are increasingly required elements of competitive research grant proposals.

### *Building Systems*

Building systems encompasses specialized research in green building, structural timber design, energy systems, material strength modeling and management/marketing of building materials. ECo has expertise in environmentally sensitive building materials & systems (green building); wood-concrete composite systems; innovative connection systems for timber structures; computational modeling of bio-based composites; energy modeling and systems design; forest products marketing and economics; computer applications in building design; and structural optimization. A major strength of our program is the unique interdisciplinary and official tie of both faculty and students to related departments and programs of building on campus; building systems faculty serve as core faculty of the Architecture & Design program on campus as well as adjunct faculty with the Department of Civil and Environmental Engineering. The interdisciplinary culture encourages joint research and funding as well as instruction. Students and faculty with backgrounds of material science, planning, architecture and engineering share research projects, labs and valuable expertise.

## **Inter-Departmental Professional MS Degree in Sustainability Science**

Several ECo faculty are also involved with the interdisciplinary professional MS degree program in Sustainability Science created in 2012. This college-based (CNS), 33-credit program prepares students professionally for a broad range of sustainability-focused careers in industry, government,

or the non-profit sector. Students in the program select one concentration area from among 4 options:

- Environmental Quality,
- Sustainable Food Systems and Agriculture,
- Water Sustainability, and
- Urban Sustainability.

Because the program combines core classes and a chosen area of concentration, students build a strong intellectual foundation for analyzing interconnections between social, economic and ecological systems, and also develop expertise depth within a given domain. Since Fall 2012, this program has enrolled 51 students with a goal of approximately 20 new students entering each academic year (26 enrolled in 2014/15), and generated in excess of \$700K in tuition and fees. Sustainability Science is a critical component of our envisioned inter-departmental graduate program in Ecology, Environmental Conservation & Sustainability (**Big Idea # 1**).

### **Our Competitors & Our Competitiveness**

Primarily, only land-grant universities offer graduate degree programs in natural resources and environmental conservation, and our graduate program is in the top tier of these programs by virtue of our size, the diversity of our faculty and their research expertise, and the active engagement of our adjunct faculty from the federal agencies embedded within our department. Further, our faculty are engaged with large multi-disciplinary research initiatives, such as the NE Climate Science Center, NSF IGERT Program in Offshore Wind Energy, DOI Landscape Conservation Cooperatives, and the MA Energy Efficiency Initiative, representing a remarkable array of multi-disciplinary research initiatives that very few other natural resource programs across the country can match. Additionally, ECo research also has a strong emphasis on interactions between people and the natural and built environments with expertise in environmental governance and decision-making. In addition, the campus is recognized as a leader in sustainability (e.g., Green Honor Roll School, Champions of Change, STARS Gold award). Our campus scored a perfect 99 in a survey of 861 schools for the 2015 edition of Princeton Review's Guide to Green Colleges, recognizing our strong commitment to sustainability in our academic offerings, campus infrastructure, activities, and career preparation. If the proposed **School of Earth, Sustainability & the Environment** is approved by the Faculty Senate, UMass Amherst would be the only university on the East Coast with a specialized school for sustainability, which would further elevate our name recognition. With the approval of the School and our proposed **Inter-departmental Graduate Program in Ecology, Environmental Conservation & Sustainability (Big Idea # 1)**, UMass Amherst would have the opportunity to launch an effective marketing campaign for academic programs and to brand our campus as the "destination of choice" for graduate students interested in sustainability and the environment throughout the Northeast and beyond.

### **Winds of Change & Faculty Hiring**

Considering that a large proportion of our research program is directed at meeting the information and research needs of state and federal natural resource management agencies and private industry, we will continue our research strengths outlined above to meet the needs of these primary partners. However, we have also taken advantage of retirements and spousal hires to build our faculty in new directions to take advantage of emerging research areas, expand opportunities for interdisciplinary

research, and better align faculty in areas with the strongest potential for extramural funding. Consequently, our recent research faculty hires have been focused in the following areas.

- Building Energy Systems & Design
- Climate science
- Conservation genetics
- Ecosystem science
- Environmental decision-making
- Environmental governance & policy
- Geospatial analyses
- Invasive species ecology
- Population/statistical ecology

Further, we have shifted some of our faculty positions into lecturer positions rather than tenure-track positions in areas that have less potential for extramural funding, but a high potential for expanding professional master's degrees. These lecturer faculty also help to fill a critical need for delivering undergraduate curricula and program administration. Our recent lecturer faculty hires have focused in the following areas.

- Building construction technology
- Building energy efficiency
- Renewable energy
- Sustainability

### **Are ECo Faculty Making their Mark?**

We think ECo faculty are very much making their mark. There are no national academies for faculty in our very applied fields of environmental conservation; yet, ECo faculty are very successful if we are judged by the leadership roles we play at solving the complex challenges of environmental sustainability in our communities, across the state and nation, and internationally, and by the research that we produce and is used to solve important environmental problems. We also believe “hitting the mark” is reflected in the leadership positions that our graduates now hold within state and federal resource management agencies and international NGOs, providing testament to the impact that ECo faculty play in training the conservation leaders of today and tomorrow.

### **Our Contributions to Public Good & Tech Transfer**

Nearly all ECo faculty engage in outreach activities as a natural outgrowth of their research, and each of us are committed to focusing our research to solve the many challenges of environmental sustainability. Consequently, the applied nature of much of the ECo research lends itself well to extension applications and tech transfer. The link between applied research and extension not only helps the University fulfill its mission as a land-grant institution, but provides opportunities to engage both graduate and undergraduate students in projects with direct application to the environmental issues and opportunities that attracted them to the department.

Our five extension faculty (more than any other academic unit at UMass) support research in ECo by engaging faculty and stakeholders in the identification of particularly important problems

and issues in conservation, and facilitating access to funding for applied research to address these issues. The department supports one tenure-track faculty position as extension forester and four non-tenure track extension faculty positions focusing on:

- Building energy conservation
- Community forestry
- Fish, wildlife and biodiversity conservation
- Forest resources conservation

Extension faculty work with other ECo faculty to create sustained research programs integrated with extension education that address critical issues and needs. Many ECo faculty participate in ongoing UMass Extension, continuing professional education, or other outreach or professional service programs. Others play a larger role in outreach by creating and organizing outreach courses and other programs.

Further, our vigorous extension program also provides a mechanism for technology transfer and community engagement that are increasingly becoming required elements of research grant proposals. Additionally, citizen science is emerging as an effective and efficient mechanism for data collection and for increased public engagement in the environment through the co-production of knowledge. Technologies such as interactive websites and smart mobile devices are increasingly used as data-gathering tools to encourage citizen participation in the scientific process.

Our faculty contribute to several federal, state, and regional priorities identified by the strategic planning subcommittee, including:

- applied life sciences
- advanced materials and manufacturing
- energy, climate science and sustainability

### **Interdisciplinary Research and Cross-Unit Collaboration**

Interdisciplinary research is at the core of our research programs both within ECo and across campus and institutions. Many ECo faculty now participate in one or more interdisciplinary graduate programs, including Organismic and Evolutionary Biology, Plant Biology, Public Policy and Administration, Intercampus Marine Science Graduate Program, and the Sustainability Science Program. Initiatives to expand our interdisciplinary research and collaboration are underway, including:

- Our proposal with Geosciences and the Stockbridge School of Agriculture (and now before the Faculty Senate) to create a new *School of Earth, Sustainability & the Environment* (described in Phase 1 of our strategic planning process);
- **Our Big Idea #1** to create a new *Inter-departmental Graduate Program in Ecology, Environmental Conservation and Sustainability* with participation of faculty in Geosciences and the Stockbridge School of Agriculture;
- **Our Big Idea #2** to create a *Center for Environmental Governance & Decision-Making* in conjunction with the proposed new *School of Public Policy*, including our extensive participation on the Provost's Advisory Committee to establish the new school;



- **Our Big Idea #3** to create cooperative regional research effort, *Headwaters to Oceans (H2O)* to enhance graduate research and teaching in aquatic biology, ecology and ecosystem science while enhancing our capacity at the UMass Gloucester Marine Station and the Cronin National Fish Hatchery;
- Expand our participation in multidisciplinary competitive grants programs, such as IGERT/NRTs, Engineering Research Centers, LTER, ULTRA-Ex, REUs, USDA NIFA, NE Climate Science Center, and MA Energy Efficiency Initiative

By collaborating with colleagues in other disciplines, departments and colleges, we are better prepared to address the next generation of environmental sustainability challenges and respond to emerging issues. This is why we are prioritizing interdisciplinary research in faculty hires. This will help ECo to realize our long-term vision of being the premier institution in the Eastern U.S. for both research and education related to ecology, environmental conservation and sustainability.

### “Think Globally, But Act Locally”

Given our department’s mission to build environmental stewardship and to making a big difference in the world, our research program already stretches from local to international scales. While our extension programs are focused primarily within communities across the Commonwealth, it’s impact extends across all of New England and beyond. ECo has a long track record of meeting the research needs of state and national resource management agencies and NGOs. Internationalization is also a vital element of our culture, and we provide an outstanding climate for international students and scholars through whom we invest much in capacity building in many less-developed countries in Africa, Asia and Latin America. Several of our faculty have research sites worldwide and bring this international research to enrich our ECo community and curricula.

## PART 1.2: REALIZING OUR VISION

### What Contributions Can We Make?

#### *Internal Reallocation*

We will continue to take advantage of retirements and spousal hires to build our faculty in new directions to a) take advantage of emerging research areas, b) expand opportunities for interdisciplinary research, and c) better align faculty in areas with the strongest potential for extramural funding. We have also shifted some of our faculty positions into lecturer positions rather than tenure-track positions in areas that have less potential for extramural funding, but a high potential for expanding professional master’s degrees. These lecturer faculty also help to fill a critical need for delivering undergraduate curricula and program administration.

#### *Increased Pursuit of Sponsored Research Opportunities*

In recent years, our faculty have greatly expanded their participation in large competitive and sponsored research programs (Table 2). Senior and early career faculty will continue their efforts to expand these funding opportunities, while continuing their commitment to meeting the research needs of our state and federal resource management agencies, NGOs, and industry partners via research contracts. Although many of these research contracts are typically smaller grants with reduced indirect costs, we are committed to providing this research as part of our mission as a public land-grant institution. Further, we believe that the implementation of **Our Three Big Ideas**,

will greatly expand opportunities for ECo faculty to obtain large, competitive, multidisciplinary grants.

Table 2. Recent (2009-2014) large research grants and contracts for ECo faculty as PI or Co-PI.

Grant/Contract	Amount	Sponsors
NE Climate Science Center	\$7.5 million	DOI U.S. Geological Survey
MA Energy Efficiency Initiative	\$6.0 million	MA DOER
IGERT Offshore Wind Energy	\$3.2 million	NSF
Restoration of Soil Microbial Function: Mediating Biological Invasions in a Global Change Context	\$1.9 million	DOD
River & Stream Continuity and Flood Hazard Mitigation	\$1.7 million	MA DOT and U.S. Fish & Wildlife Service
Designing Sustainable Landscapes	\$1.2 million	NA Landscape Conservation Cooperative
Predicting Regional Ragweed Allergy Hotspots in New England	\$1.0 million	EPA
Understanding & Informing Family Forest Owner Decisions	\$0.5 million	National Institute of Food & Agriculture
Boston Metropolitan Area ULTRA	\$0.34 million	NSF ULTRA-Ex

Recognizing that much of ECo research is funded by research contracts from state and federal resource management agencies, often via cooperative agreements with reduced overhead, these grants are an integral part of our research program and provide important public service of our land-grant mission. Consequently, we trust that the university will not penalize our research program by either explicit denial or increased roadblocks to accepting these low overhead grants.

### ***Opportunities for Private Philanthropy & Endowments***

Although several faculty do receive occasional gifts from donors for specific projects, most are very modest in size, ranging from \$20 to \$42K. However, ECo has recently received a \$2+ million bequest from Lawrence and Alice Shepard to fund graduate research in the most pressing environmental challenges affecting freshwater and marine ecosystems. Once fully realized, this endowment will play an important role in supporting graduate students as a part of our **Headwaters to Ocean (H2O)** initiative (**Our Big Idea #3**). Additionally, we are working hard to establish a MacConnell-Petri Professorship in Forest Ecology & Conservation for which we are only \$310,000 short of our \$1.5 million goal.

### ***Potential for Online Certificate or Degree Programs***

The best opportunity for ECo to develop an online certificate or professional master's degree program is in Green Building, for which we already have a well-developed on-campus degree program. Another potential area for an online program may be a professional master's degree in GIScience. Although ECo and Geoscience faculty are working together to develop an on-campus-based professional MES concentration in GIScience as part of the proposed Inter-departmental Graduate Program in Ecology, Environmental Conservation & Sustainability initiative (**Our Big Idea #1**), there may also be good potential to develop a successful online program, as well.

However, it would need to be competitively priced to compete with similar existing programs at other institutions. Other than an occasional on-line course taught by individual faculty, we see little potential for developing other online programs. Further, the limited market for online programs in Wildlife, Fisheries, and Forestry is fully saturated by larger, long-established programs at other institutions (i.e. North Carolina State University and Oregon State University).

### ***Potential for Fee-Paying Master's Programs***

Fee-paying master's programs are a key component of **Our Big Idea #1** to create an Inter-departmental Graduate Program in Ecology, Environmental Conservation & Sustainability. We believe there is great opportunity to create a substantial revenue stream for ECo via a 1-year professional Master's degree in Environmental Sustainability (MES). Although ECo has long offered students the opportunity to pursue a professional master's degree as part of our current ECo graduate program, it typically takes students two or more years to complete their degree due to requirements of a professional internship and paper. Further, the current agreement for tuition return to departments for fee-paying master's students does not provide an incentive for the department to expand these programs at this time. That said, the current agreement for the relatively new professional master's degree program in Sustainability Science has generated in excess of \$700,000 for UMass over the past three years, which has supported the faculty coordinating this program. However, **the university's policy on tuition return to departments for fee-paying master's programs will need to be modified to provide departments suitable incentives for developing and offering these programs** (see additional details in Master's section below).

### ***How Can We Better Compete for Research Dollars?***

Considering the very applied nature of much of the research that ECo faculty conduct, not all ECo faculty compete for NSF grants. Alternatively, most ECo faculty focus their research proposals on research funding available from state and federal agencies. That said, in recent years, ECo faculty have been very successful with multidisciplinary competitive grants outlined in Table 2. Consequently, we believe that the implementation of **Our Three Big Ideas**, will greatly expand opportunities for ECo faculty to better compete for large, competitive, multidisciplinary grants.

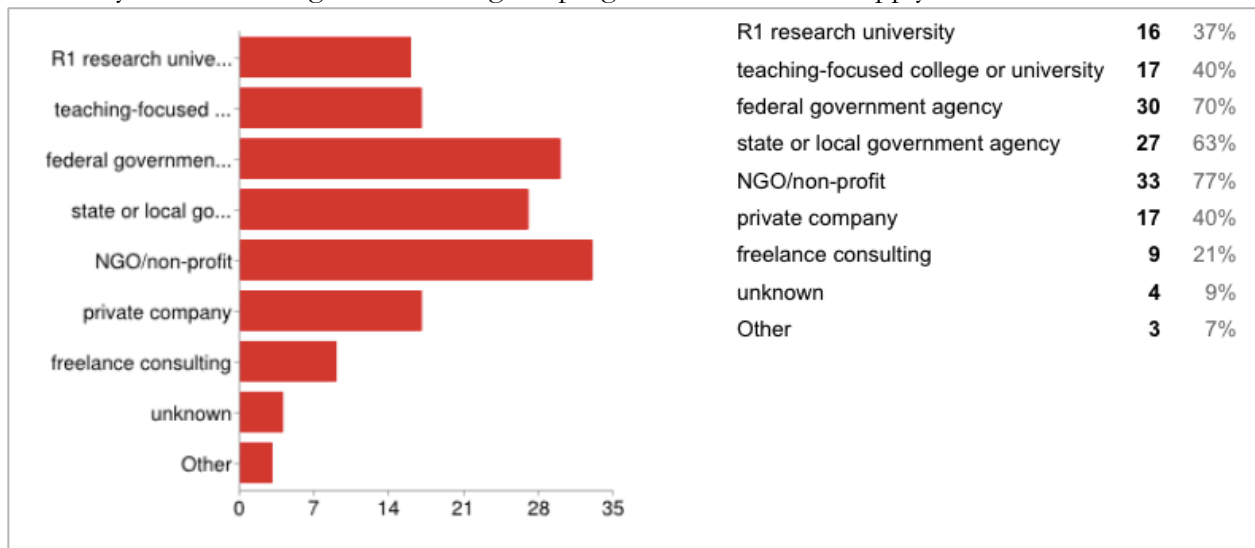
### ***The Generational Funding Gap***

Although extremely nice to tap, NSF and NIH are not an essential measure of ECo faculty research success. Rather, we pride ourselves most on achieving our mission - on making a big difference in the world by facilitating the stewardship of healthy and sustainable ecosystems that provide important human and community benefits. We also take great pride in training the next generation of scholars and practitioners able to solve the complex, global challenges of environmental sustainability. Further, a very high percentage of our graduates seek and find employment in non-academic settings (state and federal agencies and NGOs)(Fig. 3), and these are the same professional goals for many of our current graduate students (Table 3). Considering these professional goals, the very high professional employment rate of our graduate students, and the low reliance on competitive NSF-type grants, we have not experienced a particularly large generational divergence in our applied research programs. To the contrary, our early career faculty have greater access a wider range of multidisciplinary grants today than previous generations of faculty. What does this mean for the evaluation of early career ECo faculty?

- Encourage and reward participation in multidisciplinary research involving early career and senior faculty

- Encourage and reward research funding from a diverse array of sources (thereby reduce the near myopic view that NSF and NIH grants are the only worthwhile pursuits by faculty for tenure and promotion)
- Encourage and facilitate funding sources that diverge from the standard indirect cost rate
- Encourage and facilitate cooperative research agreements with a wider array of public agencies, NGOs and industries that will typically involve reduced indirect cost rates.
- Encourage and reward research that meets the critical needs of the public interest, and in particular the Commonwealth
- Encourage and reward outreach and technology transfer in the public interest

Table 3. Responses from 43 current Eco graduate students to the question, “Where would you envision yourself working after finishing the program? Check all that apply.”



### *Physical Infrastructure Needs*

A significant portion of our research is field-based and we have a culture of having our research grants support equipment needs and necessary staff. That said, our greatest need for facilities development is building the capacity of the Gloucester Marine Station and Cronin National Fish Hatchery as critical links in a cooperative regional research effort, **Headwaters to Oceans (H2O)**, to enhance our graduate research and teaching in aquatic biology, ecology and ecosystem science (**Our Big Idea #3**).

### *Centers and Institute Affiliations*

Our greatest need for center affiliation is our **Big Idea #2** – to establish a Center for Environmental Governance & Decision-Making by working with diverse faculty as part of the newly proposed School of Public Policy. This center would greatly expand our visibility and capacity to conduct research and train graduate students in the environmental governance and social dimensions of environmental conservation and sustainability.

Additionally, Eco faculty are closely linked with three on-campus centers that provide our faculty extensive and diverse research opportunities, including:

### Center for Agriculture, Food and the Environment (CAFÉ)

The Center for Agriculture, Food and the Environment advances environmental quality, agricultural sustainability, sustainability of water resources, efficiency of energy utilization and the viability of food systems, from production to consumption. The Center brings together the work of staff, faculty in academic departments, and external partners and stakeholders to create programs of integrated research and educational outreach that address high-priority public concerns. The Center facilitates mutually beneficial exchange between citizens and the university and supports community access to academic resources.

Almost all ECo faculty have strong affiliations with CAFÉ through diverse activities, including:

- Extensive research funded by the MA Agricultural Experiment Station with federal formula funds (Hatch and McIntire-Stennis – FY 15 funding ~ \$315k);
- Four Extension faculty who work with other ECo faculty to create sustained research programs integrated with extension education to address critical issues and needs;
- Engagement of university faculty and outside stakeholders in the identification of critical issues in the commonwealth and throughout the region;
- Facilitation of inter-departmental and interdisciplinary research to address critical issues;
- Serve as a clearinghouse for the dissemination of research-based knowledge through educational programs;
- Provide undergraduate and graduate student learning opportunities through community service learning, applied research and assistantships.

### Family Forest Research Center (FFRC)

ECo is the home for the Family Forest Research Center, a research partnership between the USDA Forest Service, Northern Research Station and ECo. One of the co-directors of the center is an ECo faculty, Prof. David Kittredge (ECo). The other co-director is Dr. Brett Butler (USDA Forest Service). Other center staff included one affiliated ECo Extension faculty (Catanzaro), one research coordinator, two research associates, and one graduate research assistant.

The FFRC studies the behaviors and attitudes of the people who own forestland, encompassing 263 mill acres (or 35%) of U.S. forests. Its research program seeks to improve forest conservation to meet the current and future needs of landowners, communities, and society. One of the principal responsibilities of the FFRC is to administer the National Woodland Owner Survey for the USDA Forest Service, annually surveying between 10,000 and 15,000 private woodland owners nationwide to assess attitudes and behaviors.

The FFRC has been very successful in studying targeted and relevant research questions pertaining to family forest owners, and generating tangible results. Since 2006, the FFRC has published over 40 refereed journal articles on family forest owner attitudes and behaviors. In 2012, the FFRC hosted an international meeting of the Small Scale Forestry working group of the International Union of Forest Research Organizations. Over 100 scientists from 18 countries visited UMass Amherst for a week to exchange research information. In a 2013 UMass review of the FFRC, the committee stated, “In short, the FFRC is an excellent example of a viable Center that admirably meets its own and the university’s expectations.”

### Water Resources Research Institute

The Water Resources Research Center supports research, education, and outreach on water resources issues of state, regional, and national importance as part of the **national system of institutes** authorized under the Water Resources Research Act of 1964. Established in 1965, the Center is now part of the **Center for Agriculture** at the University of Massachusetts Amherst. The Center encourages an interdisciplinary approach to resolving state and regional water problems and has involved the University system and many other Massachusetts colleges and universities in Center research.

Many ECo faculty have strong affiliations with the Institute through diverse activities, including:

- Serving as liaison between federal, state, and local representatives and water/environment expertise at UMass Amherst;
- Addressing water resources needs of the Commonwealth and New England through research, creative partnerships, and information transfer;
- Actively engage federal and state agencies in interdisciplinary, University water resources research, education, and outreach efforts.

### ***Faculty Recruitment & Retention***

We are quite successful at recruiting and retaining the top candidates from our searches. We suspect this is due to the diversity and strength of our faculty and programs; the congeniality of our staff and faculty; our supportive sense of community and mutual respect for each other; our forward-looking and adaptive approach to multi-disciplinary research, teaching and service; our strong commitment to our students; and our very strong commitment to the success of early career faculty.

Although our ECo community is more diverse now, personally and professionally, than we were a decade ago, we recognize the value of having a culturally and intellectually diverse faculty and student body. In both our non-tenure and tenure-track faculty searches during recent years, there has been a concerted effort to recruit women and members of underrepresented ethnic groups into the candidate pool. This has been fairly successful, at least with respect to hiring women faculty. As of 2006, 22% of the faculty were female and/or of an underrepresented ethnic group. Through recruitment and hiring since 2009, the figure is now 28% (9 of 32), and 4 of 8 of the tenure-track Assistant Professors are women (1 also a minority). For our three most recent lecturer hires, two are women and the third an Asian male, which are typically under-represented in our disciplines. Despite this progress, there is still far to go in recruiting a representatively diverse faculty.

### ***Promotion and Flexible Faculty Appointments***

ECo has a strong tradition of adjusting faculty appointments annually to help faculty meet their professional and promotion goals. Each fall, the DH meets with each faculty member to review their annual report and to set their appointment for the coming year. Consequently, the percent efforts for teaching, research and service are specified each year for each faculty, and these appointments are considered by the DPC in their annual reviews. These flexible appointments allow faculty to adjust their efforts in each area to maximize their productivity for the year. Further, our DPC and the ECo community as a whole have a very strong tradition of mentoring early career faculty, making sure they are on track for successful tenure and promotion outcomes. Additionally, through the support and encouragement of the DPC and DH, our associate professor faculty are tracking well for promotion to full professor rank.

## PART 2: OVERVIEW OF OUR DOCTORAL AND MASTER’S DEGREE PROGRAMS IN ECo

Graduate students (both MS & PhD) and postdocs are at the core of our ECo research program, and the future of our graduate programs is intricately tied to the creation of the proposed Inter-departmental Graduate Program in Ecology, Environmental Conservation & Sustainability - **our 1<sup>st</sup> Big Idea**. Our vision is to train the next generation of scholars and practitioners able to solve the complex, global challenges of environmental sustainability. We intend to grow a diverse group of graduate students in disciplines where there is faculty expertise and viable career paths.

ECo’s total graduate enrollment, including doctoral and master’s students, increased 37% between 2004 and 2013, compared to an overall 8% for CNS and 4% for UMass graduate enrollment during the same period. Similarly, graduate enrollment in colleges of forestry and natural resources at 76 land-grant institutions nation-wide between 2004 and 2013 increased 14.5% (Food and Agricultural Education Information System, <http://faeis.usda.gov>, accessed 4/2/15).

Over the last four years (2010-2014), ECo faculty have advised over 260 MS and PhD students of which the gender ratio was approximately 50:50 (132 male:128 female). Numbers of graduate students across PhD, MS research and MS professional programs were similar (Table 4) with the majority (66%) of graduate students advised by ECo faculty in the ECo graduate program (Fig. 1). Of the 262 graduate students advised by ECo faculty between 2010 and 2014, 123 graduated, 12 left the program, and 123 remain registered in their respective graduate program. Of the current 123 graduate students, 59 are in PhD, 34 in MS research, and 30 in MS professional degree programs.

Table 4. Numbers and percent of graduate students advised by ECo faculty in PhD, MS research and MS professional programs, 2010-2014.

	No. of students	Percent
PhD	90	34%
MS	87	33%
MS Professional	85	32%
	262	

The ethnicity of our graduate students over this period was largely white non-Hispanic (82%), 13% other, and 5% Asian, which is similar to graduate enrollment in colleges of forestry and natural resources at 76 land-grant institutions nation-wide between 2004 and 2013 (Food and Agricultural Education Information System, <http://faeis.usda.gov>, accessed 4/2/15).

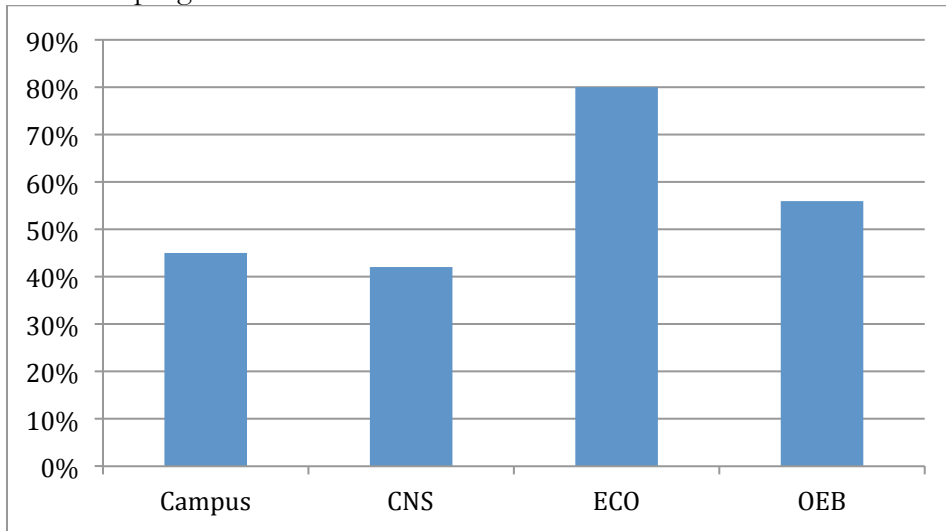
ECo is a recognized leader in the field of international wildlife conservation. As a result, the graduate student body is comprised of a substantial number of international students (12%). Their presence and involvement in the program helps to foster student diversity and promote global perspectives on fish and wildlife conservation issues, and the diverse world views and experiences they bring to the program, both inside and outside of the classroom, adds substantial breadth to our ECo community.

The graduate program has more highly qualified PhD and MS applicants than can be accepted, even without any concerted effort at promoting the programs. For the MS research and PhD programs, we advise prospective students not to apply to the program unless they have prior contact with a faculty member and secured their willingness to serve as their major advisor. Many ECo faculty follow this process because they often need students with specific skill sets (i.e. bird ID,

animal trapping, advanced quantitative or GIS skills), so students are able to ‘hit the ground running’ and accomplish their research without extensive skill training. The availability of external research funds to support a student’s research project is typically the main criteria for accepting new graduate students by faculty. Consequently, there are more highly qualified PhD and MS applicants than can be accepted by ECo faculty.

ECo has a high yield rate of students accepted into our programs who decide to enroll. For our doctoral programs, 80% of accepted applicants enroll in our program, compared to much lower rates for the campus, CNS, and other programs (Fig. 4).

Fig. 4. Percent yield of students accepted into ECo’s doctoral program compared to campus, CNS and other programs.



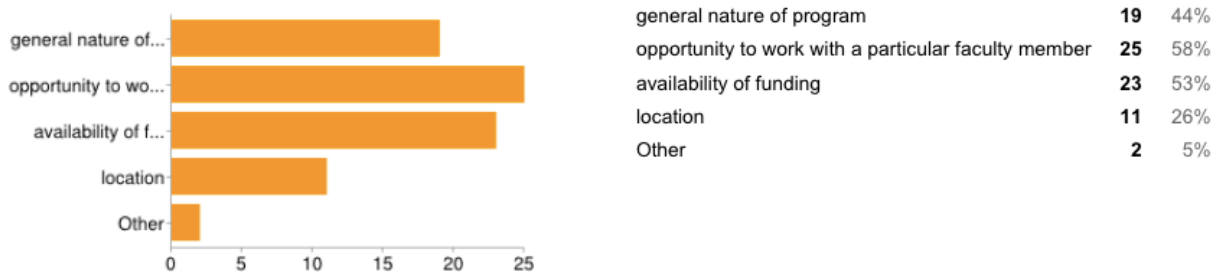
### What Our Graduate Students Say

As a part of this strategic planning process, ECo graduate students conducted their own survey to inform the strategic planning review. Additionally, in spring 2013, the department conducted a climate survey of all ECo graduate students on a wide variety of topics, including diversity and equity. Highlighted below are the responses from ECo graduate students relevant to this graduate program review.

ECo graduate students indicated that the opportunity to work with a particular faculty member and availability of funding were the two most important reasons affecting their decision to attend UMass (Fig. 5). This reinforces our belief that graduate students come to ECo for the expertise of our faculty and the opportunity to conduct similar types of research for their MS or PhD research. Further, most faculty do not typically take on new graduate students for research degrees unless they have a funded project to support the student’s research.



Fig. 5. ECo graduate student (n=43) responses to the question, “Why did you decide to attend UMass? Check all that apply”.



Certainly, the availability of funding is very important factor in a student’s decision to attend UMass for graduate training for MS and PhD students alike. Although we don’t know how competitive our TA and RA stipends are compared to our peer institutions, colleagues in a similar program at the University of Rhode Island (URI) have told us that they are at a major disadvantage of attracting graduate students and securing grants, especially from state and federal agencies, because URI does not provide any tuition or fee waivers for their students on RAs.

Unlike many other graduate programs in CNS, many of our graduate students want careers in state and federal resource management agencies and NGOs, and to a lesser extent in academia. Further, a very high percentage of our graduates seek and find employment in non-academic settings (state and federal agencies and NGOs)(Fig. 3), and these are the same professional goals for many of our current graduate students, as well (Table 3). Consequently, our research program is typically very applied and focused on solving the resource management challenges of state and federal resource management agencies and NGOs, our primary research stakeholders.

Our current graduate students are funded from a variety of sources with RAs and TAs the most important sources (Table 5). Yet, it is common for many ECo graduate students to have less than 20 hours of TA/RA support during their program (Fig. 6).

Table 5. ECo graduate student (n=43) responses to the question, “Check all of the ways you have been or currently are supported within the program.”

Response	N	Percent
I have not received any funding	5	12
TA	20	47
RA	26	60
Fellowship (e.g., Fulbright, Beinecke, Const, NSF, Grad School)	10	23
Externship	3	7
Other	5	12

Fig. 6. ECo graduate student (n=43) responses to the question, “What is the most common level of support you have had during the program.”



As a part of our broader climate survey in spring 2013, we asked our graduate students a variety of questions relating to their satisfaction with the ECo graduate program as part of a broader climate survey (Table 6). Overall, this survey indicated that the ECo graduate program is providing students a welcoming and inclusive environment (4.34), a helpful faculty (4.32), and a very good intellectual climate in preparing students for their careers (4.08). However, there were slightly lower scores for preparation for professional opportunities (3.76) and continued educational opportunities (3.8). With respect to specific skills, there is lower agreement that the ECo program is providing ample opportunities to develop communication skills (3.65) and provide technical/research training (3.5). Given our vision for the program with respect to training students for a diverse and ever-changing workforce, these numbers indicate both the strength of the current program as well as room for improvement.

Table 6. Responses from ECo graduate students concerning the graduate program, spring 2013.

Please indicate how much you agree or disagree with each of the following statements:					
<i>Strongly Agree (5)</i>	<i>Agree (4)</i>	<i>Neither agree or disagree (3)</i>	<i>Disagree (2)</i>	<i>Strongly Disagree (1)</i>	<i>Not applicable (1)</i>
Statement					Mean score
I am making satisfactory progress in my graduate program.					4.1
The ECo program is preparing me well for professional opportunities.					3.76
The ECo program is preparing me well for continued educational opportunities.					3.8
The <i>intellectual</i> climate in the ECo program is preparing me well for my career.					4.08
The <i>social</i> climate in the ECo program is preparing me well for my career.					3.59
The ECo program is providing ample opportunities to develop my communication skills.					3.65
The ECo program is providing ample technical/research training opportunities.					3.5
I am satisfied with the level/quality of the mentoring I am currently receiving.					3.69
Faculty members and staff are open to assisting me if I have problems or concerns.					4.32
The ECo program provides a welcoming and an inclusive environment that is respectful of diversity.					4.34

## Part 2.1 ECo’s Doctoral Program

### Building On Our Competitive Advantages

Achieving our Three Big Ideas is the most effective strategy for building our competitive advantage in graduate education and to build upon our existing considerable strengths in our areas of emphasis:

- Climate and Conservation Science
- Ecology and Conservation of Plant and Animal Populations
- Ecology and Conservation of Landscapes, Watersheds, and Estuarine Ecosystems
- Effects of Urbanization on Natural Resource Conservation
- Environmental Governance and Decision-Making

Further, we will continue to shift some of our faculty positions into lecturer positions rather than tenure-track positions in areas that have less potential for extramural funding and for attracting graduate students, but a high potential for expanding professional master's degrees. These lecturer faculty also help to fill a critical need for delivering our undergraduate curricula and program administration.

### **Our Highest Priorities for Improving Our Doctoral Program**

A vibrant graduate program that can recruit top-notch students requires sufficient financial and programmatic support to create a strong sense of financial equity, academic identity, and community among the students. We believe that providing logistical and funding structure in these areas will not only enrich the educational experience of our PhD students but also result in the recruitment of better students, lower attrition rates, increased satisfaction with the program, and enhanced research productivity. We identified several areas in which we already serve some of these needs (e.g., new mentoring program, monthly program meetings, departmental scholarships and TA support), but also ways that we could strengthen the program considerably with additional activities and resources, including:

- Shifting to a more flexible admissions policy, allowing highly qualified students to enter directly into a PhD program instead of the current policy that requires all entering PhD students to have completed a MS.
- Developing a more stable and equitable source of salary support, possibly using a strategy of combined “guaranteed” TA support in conjunction with RA support from research grants.
- Hiring a graduate program manager to be the “go-to” contact for all new and continuing students regarding the logistics of the program, questions and problems that arise and a critical “non-faculty” source of advice on how to succeed in the program. In addition this person would coordinate seminars & events, oversee admissions and graduation processes and support all other functional aspects of the program.
- Instituting an annual ECo Graduate-Faculty Retreat featuring graduate student and faculty research featuring a symposium-style series of grad student and faculty research talks, break-out discussions for groups working in related and complementary fields, and ample social & recreational opportunities for students and faculty to interact.
- Providing a consolidated physical space for graduate students for offices, a conference room, and a social meeting/lunch space. A space where students can see one another daily, work in shared space, give informal and formal research presentations, and meet for seminars is a vital missing link in creating an atmosphere of connection and cultural continuity in the program.
- Expanding opportunities to develop better communication and technical/research skills (based on a survey of graduate students conducted in 2013)

### Diversity in ECo Graduate Students

Although our gender diversity is near equal in the ECo graduate program, only 13% of our graduate students were underrepresented minorities between 2010-2014. While this is similar to graduate enrollment in other colleges of forestry and natural resources at 76 land-grant institutions nationwide, this proportion is much lower than we want and expect. To facilitate this, we have established a first-year graduate student mentoring program and conducted a workplace climate survey for graduate students, and are working to develop workshops with faculty and students to identify strategies and implement improvements to identified needs, and prioritizing minority students for departmental fellowships.

### Recruitment Goals

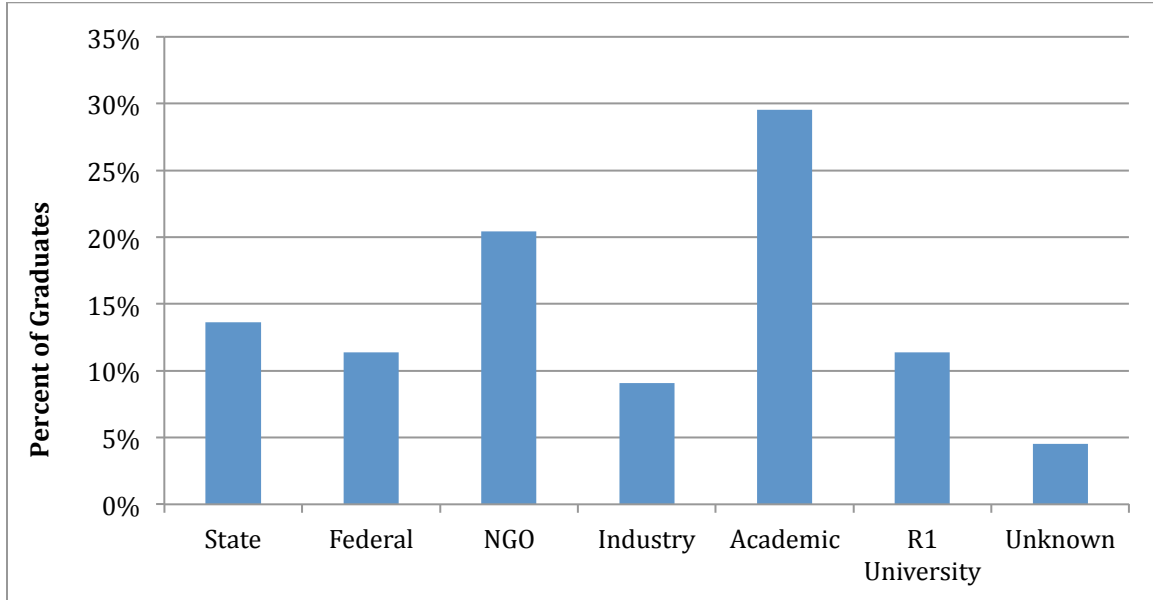
Although our ECo graduate program grew by 37% between 2004 and 2013, we expect more growth once the proposed Inter-departmental Graduate Program in Ecology, Environmental Conservation & Sustainability is approved. Faculty from other departments will take on graduate students for research MS and PhD degrees in this new program; however, this increase will be largely driven by the ability of faculty to support new students with extramural research grants and contracts. We expect substantial increases in enrollments of students in the new one-year professional master's degree in Environmental Sustainability. Our goal is a minimum of 15-20 students in each of the 6-7 concentrations developed for this program. However, to achieve this goal, **the university's policy on tuition return to departments for fee-paying master's programs will need to be modified to provide departments suitable resources and incentives for developing and offering these programs** as well as supporting the students enrolled in the programs (see additional details in Master's section below).

### Career Pathways for Our Doctoral Students

There are many career pathways for our doctoral students upon graduation. Many work for agencies, NGOs, and industry and about 40% in academia (Fig. 7). Consequently, our students have many options over and above R1 universities.

We recognize that our graduate programs are training professionals for a career outside of academia. Many of our programs are field-based and/or provide students with relevant career, skill-based training. We have strong ties to state and federal agencies and many of our students have direct opportunities to work for and/or study with representatives from those agencies with about a 25% of our doctoral students working for agencies after completing their degree.

Fig. 7. Careers chosen by doctoral students advised by ECo faculty who graduated between 2010-2014.



### Linkages Between Graduate Student Support and Undergraduate Teaching

Neither our doctoral nor master’s degree programs are tied directly to teaching responsibilities to service our undergraduate education needs. Although upwards of 60% of our MS and PhD students receive some TA support during their graduate program in ECo, the TA allocation for ECo is not large enough to sustain the relatively large numbers of graduate students in our programs (n = 123). If we were to adopt a similar model used by the OEB program that guarantees each student 20 hrs/week TA support, we would only be able to support 11.5 graduate students with our current allocation. Consequently, our TA allocation is simply too small to support the approximately 60 PhD students currently advised by ECo faculty.

That said, we require all of our PhD students to obtain at least one semester of teaching experience as a part of their training. Some fill traditional TA roles, while others offer special topic seminars for upper-level undergraduates in their specialty. We have also invited graduate students to participate in Faculty Learning Communities that were developed by ECo and the Center for Teaching & Faculty Development.

## Part 2.2: Our Master’s Programs

### Background

Currently, ECo faculty mentor and train MS graduate students in a variety of ways. The ECo Graduate Program offers options for an MS thesis (research) degree or MS professional (non-thesis) degree in five areas of concentration, including:

- Building Systems
- Environmental Policy & Human Dimensions
- Forest Resources and Arboriculture
- Water, Wetlands and Watersheds
- Wildlife, Fish and Conservation Biology

Both degree options provide students a strong foundation in three areas: core science (biology, ecology, conservation and environmental building design), quantitative science (statistics, GIS and modeling), and human dimensions (environmental policies, economics, politics, administration, management and values). The thesis degree centers on the completion of a major independent research project and a judicious coursework load, and is intended to prepare students for professional employment as working scientists and for the option of pursuing a PhD.

The professional degree focuses on substantial coursework and a professional paper based on an internship/practicum, and is meant to be a terminal degree for students seeking graduate-level training in a particular field of study and a career as a professional conservation practitioner.

In addition, ECo hosts the CNS interdisciplinary MS professional degree in Sustainability Science that prepares students professionally for a broad range of careers in industry, government, or the non-profit sector. Students focus one of four concentration options (Environmental Quality; Sustainable Food Systems and Agriculture; Water Sustainability; Urban Sustainability), undertake substantial coursework, and complete a 4-credit project with an NGO, government agency or company. Sustainability Science students often interact with fellow students from other closely-related graduate programs (e.g., Environmental Conservation, Geosciences, Landscape Architecture and Regional Planning, Architecture) to help build a professional network across a wide range of disciplines.

Finally, many ECo faculty also guide MS students in one or more campus interdisciplinary graduate programs (e.g., OEB, Plant Biology, Public Policy and Administration) and the UMass Intercampus Marine Science graduate program.

## **Why Are Our MS Degrees So Valuable to Students, UMass and Beyond**

### ***Benefits To the Students***

In contrast to many graduate programs in the life sciences, **the MS degree in Environmental Conservation is a critical credential needed for students to gain professional employment.** This is because in the field of applied sciences, the need and opportunity for employing PhD-trained students is markedly less than for those students with MS degrees. Our field is unlike the general fields of science and engineering where universities award 7 times more PhDs in science and engineering than there are newly available faculty positions, the most commonly perceived employment opportunity (Schillebeeckx et al. 2013). We train graduate students that can and do work in professional positions that require advanced scientific and technical training. These positions may be in academic institutions, but more commonly are in local, state and federal government agencies; NGOs; and business/industry/consulting firms. Since 2010, 84% of 43 ECo MS research grads, and 97% of 29 ECo professional MS degree grads work in these non-academic positions.

In ECo, we are able to train, and take pride in training, a wide variety of MS students. Of 105 ECo MS students that completed (within the past 4 years,) or are currently completing, their degrees, 54% are women, 14% are Hispanic/Asian/other non-white, and 8% are international (e.g., China, India, Indonesia, Mongolia, Myanmar, Pakistan).

To train our students, we provide support via mentoring, project funds, and an atmosphere of collegiality, scientific excellence, and collaboration. Financially, we are able to support MS students in a variety of ways. Of 73 recent or current (since 2010) MS research students, only 5% were funded only with TA funds, 40% were partially funded with TA funds but otherwise with other research funds, and 55% were funded with funds from research assistantships, fellowships, or externships. For 32 recent or current profession MS students, funding was 6%, 28% and 66%,

respectively. In the Sustainability Science MS program, 50 of 52 students fully paid the tuition/fee/etc. costs for their education; the other 2 received some partial support via other means, but not via a university TA.

In addition, **an essential part of MS graduate student funding comes from tuition and fee waivers.** With the exception of URI, we know of no peer-institution programs in the same field as ours that does not offer tuition and fee waivers for MS research students. We could not compete for qualified students without them. In addition, the clear consensus among current MS students in our program is that **they would not have come to our program, and could not continue in the program, if such waivers were eliminated.** There is no cost accrual, much less savings, to the University if waivers were eliminated. We take on graduate students to provide training to people who will make the biggest impacts on environmental conservation, including students from amongst the poorest places in the world. We attract the best and the brightest because they will move into positions that have the best opportunities to accomplish major conservation goals, and these students come to ECo because the University supports them adequately with the financial help they need and take great pride in. *We believe that tuition waivers for MS students in ECo are one of the best investments that the University ever makes in terms of providing support to deserving students who will make significant impacts in their chosen field, most especially for international students from less-developed countries around the world.*

### *Benefits To the University*

Scientific publication is the hallmark of a research university's prominence. MS research and professional students in the ECo graduate program are expected to publish at least one paper from their research or special project work in refereed journals. Recent (since 2010) and current **ECo MS students have been lead or co-authors on 66 such publications** (vs.128 for PhD students), nearly all of which were co-authored by their mentoring faculty member. This matches the expectations of the funding sources for these students who are addressing conservation questions posed by state agencies, federal agencies, and NGOs that expect answers in a timely and efficient manner. The relatively rapid development and publication of new knowledge by MS students contributes greatly to the research programs of faculty, especially early career faculty in promotion and tenure.

Students in our MS professional degrees are expected to pay full tuition and fees for their program, without expectation of any university assistance. To make this option viable, we offer training in very specific fields (rather than a general field offered by nearly all other graduate programs in our field), and in fields for which there are clear employment opportunities for the future. The funding generated from such programs significantly supports their operation; for example, in the past 4 years, the MS Sustainability Science program has generated over \$700,000 from students in that program.

### *Benefits To the Commonwealth, the Nation, and the World*

Land-grant universities such as ours were established as places offering "public education for public purpose" (UMass Amherst Sec. Doc. No. 93-021) to "**benefit the people in Massachusetts, the nation, and the world**" (cf. Trustee Document T05-024). Our MS programs are an essential component of this mission because our training is tied directly to agencies and organizations that employ our graduates. We and our on- and near-campus partners carry out essential research to answer important conservation questions for the Massachusetts Department of Fish and Game, several federal agencies (DOD, NMFS, NPS, USFWS, USGS), and NGOs, such as The Nature Conservancy, Wildlife Conservation Society, and National Geographic Society. We train students from many foreign countries (via Fulbright and LASPAU fellowships, governmental

awards, and NGO scholarships) who have and will become the leaders in their field upon returning home. Finally, we also play a pivotal role in fulfilling the university’s promise of **“embracing responsibility for the sustainability of the planet, for the progress of society, and for the development of each individual”**.

## **Our Vision**

As outlined in Part 1.1: Our Vision and ECo’s Three BIG IDEAS, we and other partners propose to create an inter-departmental graduate program in Ecology, Environmental Conservation & Sustainability by restructuring our current departmental ECo graduate program and the CNS inter-departmental graduate program in Sustainability Science. This new inter-departmental graduate program would address our needs, improve the quality of our graduate programs, and provide the framework to:

- Increase program effectiveness and student engagement
- Maximize attractiveness to prospective students
- Create cohesion within and across our graduate programs
- Improve our capacity to expand existing interdisciplinary programs and develop new ones
- Expand our revenue stream through the expansion of 1-year professional master’s degree programs

ECo recognizes the evolving educational needs of today’s and tomorrow’s workforce. Increasingly, students are seeking post-undergraduate training. However, they are selecting programs that are time-efficient, focused, and cost-effective relative to their career path. While some students want a master’s degree involving research, others are focused on more professional training that enhances their employment opportunities. ECo’s experience with the Sustainability Science program demonstrates there is a growing interest in one-year programs that are more focused and tailored to the professional goals of individual students. This degree option makes a lot of sense for students interested in careers in state and federal agencies, NGOs, or industry.

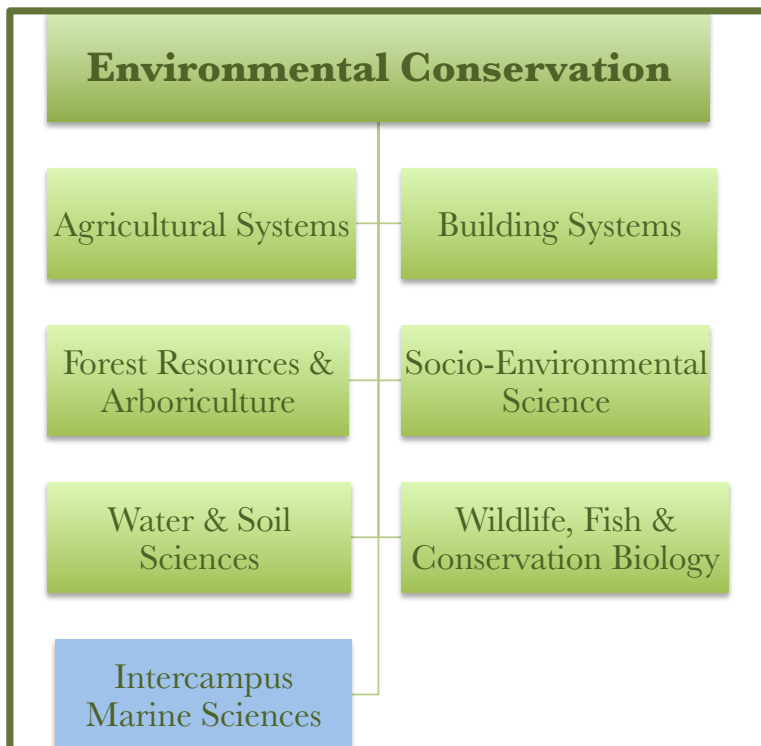
Additionally, it would also meet the expressed need of colleagues in the Stockbridge School of Agriculture and Geosciences for an inter-departmental graduate program to train some of their graduate students in areas of environmental sustainability and a variety of other professional master’s degree concentrations.

Within this new inter-departmental graduate program, MS research degree students will have more opportunities to be trained in a wider diversity of environmental conservation disciplines, and incorporate the best of interdisciplinary collaboration opportunities and exchanges. Similarly, the new professional Master degree in Environmental Sustainability (MES) will expand opportunities for students wanting to enhance their credentials for professional employment. Further, this MES degree program is designed to be entirely self-sustaining financially. These are forwarding-thinking changes that require only modest resources in terms of faculty and infrastructure, but will greatly enhance the reputation of the Department, College, and University.



*Inter-Departmental Graduate Programs*  
*in*  
**Ecology, Environmental Conservation & Sustainability**

*Research – MS & PhD*



*Professional - MES*

