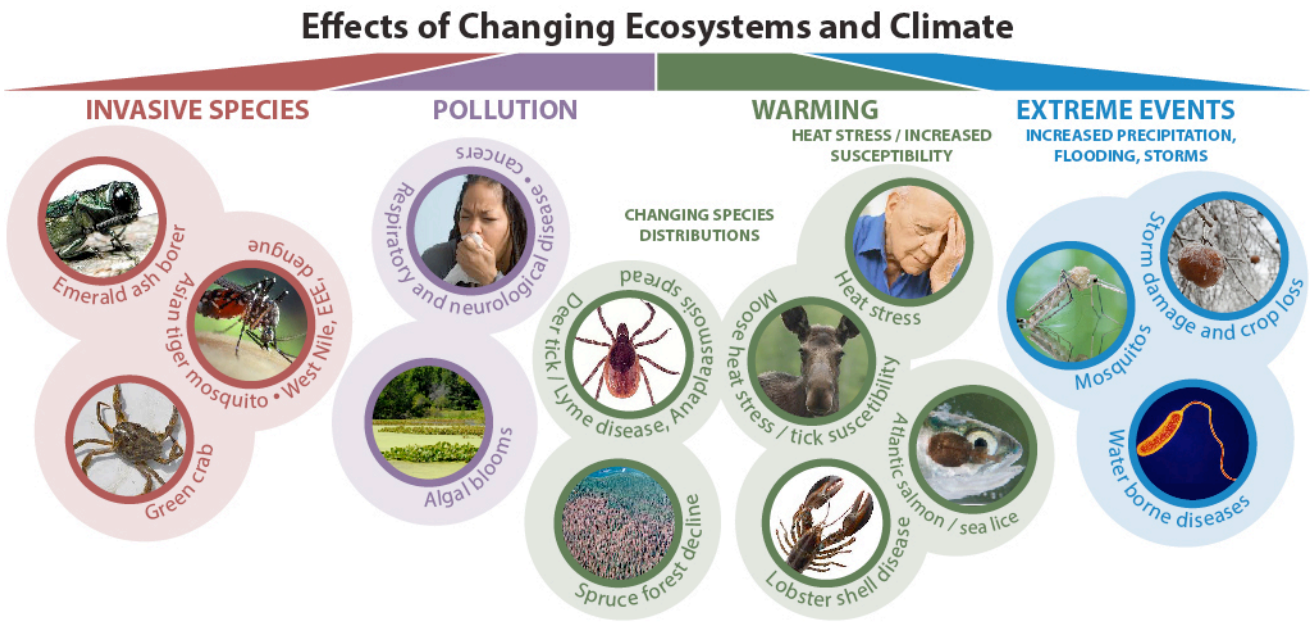
Emerging Educational Area: **Changing Ecosystems and Climate: Impact on Animal & Human Health**

The dynamic history of the natural world is driven by climate and geologic change, bringing subsequent evolution, invasion, and sometimes extinction of species. Mankind has always influenced the environment through population growth, migration, and through technical, social and cultural changes. However, the current *rate* of change and *scale* of human impacts are unprecedented. The consequences of climate, ecosystem, and human change are yet to be understood. As our changing climate coalesces with other human influences (e.g., pollution, introductions of exotic organisms), we are beginning to see significant direct and indirect effects on animal, plant, and human health. Our proposal focuses on academic programs in human and animal health, but plant health is discussed because, as food, plant health influences animal and human health.

The Problem



Global commerce has resulted in the introduction of exotic species, such as the green crab and the emerald ash borer, which threaten the health of our ecosystems, and the Asian tiger mosquito, which transmits human (West Nile virus, Dengue) and animal diseases (Eastern equine encephalitis). Warmer temperatures have led to the northward shifts of disease vectors and other pests introducing human, plant, and animal diseases previously unknown in Maine, thus damaging human health, and forest and agricultural productivity. Warmer temperatures are increasing the frequency of days with unhealthful levels of air pollutants, adding to the health stress associated with high heat. Similar indirect deleterious effects of warming are observed in our human and animal populations: heat stress has dramatically increased the impacts of parasites (e.g., ticks on moose/deer/humans, sea lice on Atlantic salmon) and disease (e.g., shell disease in lobster). Extreme weather events, becoming more common, introduce wind-blown pests into the state, contaminate surface waters, increase human injuries and fatalities, and damage human structures, the natural landscape, forest and croplands. In Maine we stand to be particularly impacted by climate change effects on health, as the people most vulnerable to climate health outcomes, (heat stress, air pollution effects, water- and foodborne illness and vector-borne diseases), are children, outdoor workers and the elderly (which is a large and growing segment of our population).

The economic effects of animal, plant and human health losses are far-reaching in scale and scope. In-migration of invasive species (e.g., dengue virus) or increased prevalence of a host species (e.g., deer ticks which spread Lyme disease) can lead to direct and severe economic losses to people through increased morbidity (i.e., economic losses through increased medical spending, and lower work productivity for both the sick person and the caregiver), and mortality. They can also lead to economic losses that are spread throughout the economy; for example, the invasive green crab or the emerald ash borer has the potential for large harvest losses in Maine's marine- and forest-based economies. Increased presence of disease vectors in Maine's forestland can also have large impacts on the health of outdoor workers (e.g., loggers, hunting guides, tippers) and outdoor recreationists (e.g., hikers, paddlers, anglers). These losses in harvests and increases in labor and insurance costs will lower the profitability of these resource-based industries, leading to lower wages and fewer jobs, which in turn, will have a ripple effect and multiply as they move through the local and state economies. These losses in economic activity will lead to lower tax revenues while raising the costs of income-support programs – which limit funds for other worthy activities supported by state and local governments (e.g. education, transportation improvements). Finally, the uncertainty of climate change and its associated impacts is costly to state and local agencies and to businesses that need to plan for the future. Planning activities take longer and are riskier, and financing for new and expanded infrastructure/activities and insuring against potential losses, becomes more expensive – all leading to a subtle, but potentially significant, drag on economic activity.

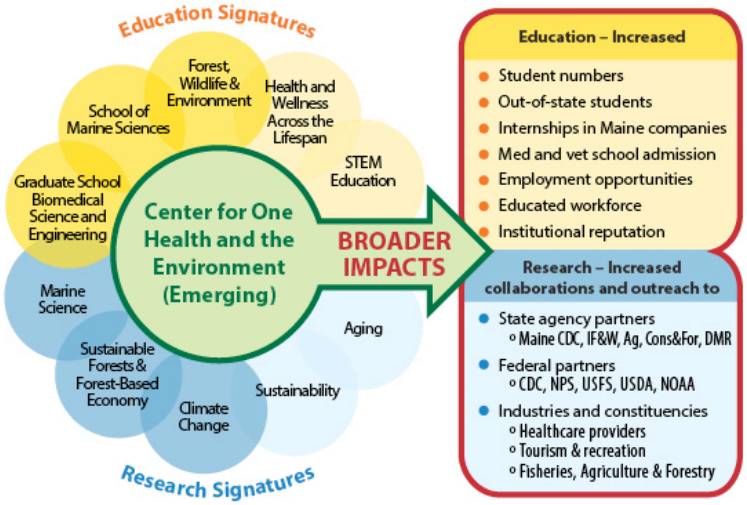
Poised for Solutions

The University of Maine stands poised to address these emerging issues with the establishment of the ***"Center for One Health and the Environment".*** Our proposed emerging, interdisciplinary research and educational area, *"Ecosystem and Climate Change: Impacts on Plant, Animal and Human Health",* builds on the theme of the *One Health Initiative*, "an international movement expanding collaborations and communications in all aspects of health care for humans, animals and the environment" in order to "advance health care for the 21st century and beyond" (http://www.onehealthinitiative.com/).

Center for ONE HEALTH and the ENVIRONMENT at UMaine

The *One Health Initiative* acknowledges that interdisciplinary collaborations between and among biophysical and social scientists working in human, animal and environmental health will accelerate discovery in biomedical research, enhance efficiencies in public health, and improve health education and practice. Central to *One Health* is the concept that human, animal and ecosystem health are "inextricably linked". Addressing the connections between health of all species and the environment will contribute to our understanding of the basic science, and will generate novel, innovative solutions to critical health and environmental challenges, both current and future. At the University of Maine, we are particularly well positioned to contribute to and be recognized for a *One Health* focus in research and educational programs, having over 45 faculty members with relevant expertise (see Table 1, Emerging Research Area proposal). We have a depth of expertise in ecological and environmental sciences, and an internationally recognized research institute focusing on climate change (CCI), the largest threat of our time to animal, human, and ecosystem health. We have faculty conducting biomedical research with model organisms such as zebrafish, which directly translates and contributes to our understanding of susceptibility and disease development and manifestations across organisms, whether fish, cows, moose, or humans. We have a research and Cooperative Extension Animal Health Laboratory

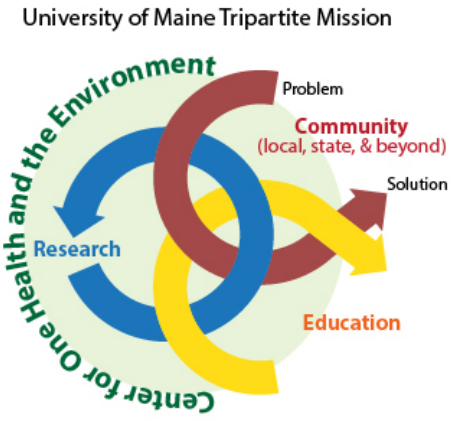
(UMAHL), with a focus on health of domestic animals and wildlife and zoonosis (diseases passed between animals and humans), and faculty investigating the movement of animal carriers of disease. We have *many* faculty investigating the impacts of climate and other exacerbating environmental stresses (toxicants, invasive insects, pathogens, and parasites) on fish, wildlife, plants, domestic animals, and humans, at the population, organism, cellular, and molecular level. Finally, we have various social scientists that focus their research and teaching in environmental and health economics and policy. They study the negative economic impacts of a changing health landscape, economic benefits and costs of adopting climate-change adaptation and resilience policies, alternative financing and risk-management policies, and health communication strategies to help people adjust their behaviors to these emerging health risks. Hence, our moniker *One Health, Many Organisms* captures the breadth that we bring to the *One Health* concept; we develop and evaluate environmental and health management strategies and policies to solve the myriad of plant, animal and human health issues arising within the state as our climate and ecosystems change.



Our initiative is about *"making connections"* – connecting our strengths in ecosystem and climate change sciences with high-demand educational programs in animal and human health, and health economics and policy; connecting our health programs across organisms from marine fisheries to wildlife to domestic animals and humans; and connecting between policy, economics, health, and the environment. Such connections will ensure the most effective use of faculty expertise and campus facilities to meet the high and growing student demand for health-related courses and majors. Table 1 lists current courses relevant to these connections between ecosystems and health. This initiative also builds on, and connects with, the (proposed) research signature programs, *Climate Change*, *Marine Science*, and *Sustainable Forests,* and (proposed) educational signature programs, *Graduate School of Biomedical Science and Engineering*, *School of Marine Sciences*, and *Forests, Wildlife, and the Environment*. It will synergize with the proposed emerging research areas of *Aging* and *Sustainability*, and the proposed emerging educational areas of *STEM Education* and *Health and Wellness Across the Lifespan*.

The Land Grant Tripartite Mission

Although we were requested to submit separate research and educational proposals, this initiative is specifically designed to meet the tripartite mission of the land grant university of research AND teaching and outreach. The research focus is aimed at addressing critical emerging issues for the state and beyond related to plant, animal, and human health impacted by climate and other environmental factors affecting ecosystem change, of relevance to all of the major industries and constituencies within the state. As we build in this area in the future, we have specifically identified key positions that both: a) provide pivotal expertise for synergizing collaborations across biophysical and social science research faculty addressing these issues, and b) also meet critical teaching need in high demand programs in health sciences. Our



graduate AND undergraduate students contribute directly to our research programs and our research programs greatly enrich our undergraduate programs. Our faculty regularly engage both graduate and undergraduate students in research and outreach activities, providing our students with valuable hands-on learning experiences through internships with state agencies, partners and industries.

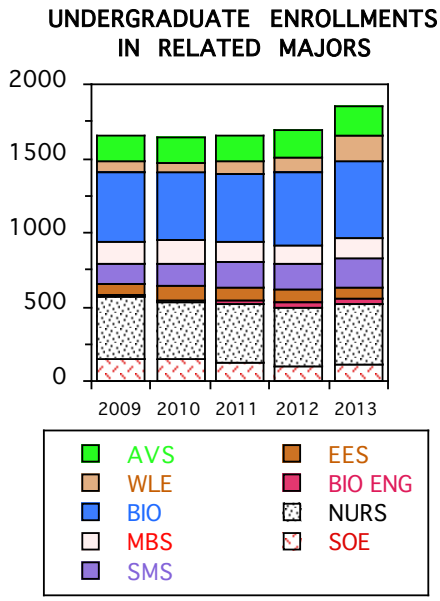
1. Demonstrates a strong "fit to place" defined as: a.) meets Maine's cultural, workforce, and economic needs; b.) actively building on Maine's existing and future resource base; and c.) fostering community engagement. Maine's economy and cultural history is tightly interwoven with the health of our farms, forests, rivers, lakes, shoreline, and ocean. Both work and recreation in Maine are intimately tied to our natural resource base, which is dependent on healthy ecosystems, workforce, and populace. Despite wise stewardship, the health of Maine's animal, plants and human systems are increasingly subject to regional and global pressures of climate change, pollution, and invasive species. Maine's landscape, which reflects a sharp transition between boreal and temperate biomes and a recent post-glacial history, is predicted to be disproportionately affected by climate changes and particularly vulnerable to invasive species and pathogens. Many of Maine's most socially and economically important species, e.g., balsam fir, moose, lobster, and Atlantic salmon, are threatened by climate-related health concerns. Invading pathogens and parasites are impacting forest, crop, animal and human health. For example, lobster shell disease, MSX and vibriosis in shellfish, and sea lice in salmon are all on the rise, hurting or even shutting down the economic productivity of these industries. Maine's CDC has identified the northward spread of arthropod vectors of infectious diseases, including Lyme disease, Eastern Equine Encephalitis, Powassan virus, anaplasmosis, and West Nile Virus, as major public health concerns. In fact, with Maine's aging population, an outdoor workforce supporting our natural resource based economy, and a tourist industry directly linked to outdoor recreational activities, our resident and tourist populations are particularly at risk from new vector-borne diseases, as well as health complications resulting from rising temperatures, increased pollutants and greenhouse gases, and extreme storm events and flooding.

This emerging educational initiative on "**Changing Ecosystems and Climate: Impact on Animal & Human Health"** will focus on both developing the workforce needed for Maine's expanding healthcare and health management sectors, and education and training for workers in our forestry, agriculture, and tourism industries, and conservation, health, and policy-related state and local agencies.

Faculty and student participation in outreach efforts will foster engagement with the greater Maine community. *This initiative will touch all major sectors of our economy* through: a) direct involvement in internships and collaborative projects, and b) outreach activities focused on plant and animal health and pest and disease vector management. Internships and collaborations with healthcare industries, state and federal agencies and parks, local municipalities, and agricultural, forestry, aquaculture, and tourism industries will benefit both undergraduate and graduate students, and contribute to outreach activities fostered through the Maine Agricultural and Forestry Experiment Station (MAFES) and Cooperative Extension.

2. Demonstrates growth potential through rising prominence in attracting top-tier undergraduates and/or competitive graduate students. UMaine's undergraduate degree programs in biology (SBE and MBS) and animal science (AVS) currently attract top-tier students with interests in medical school, veterinary school, other post baccalaureate professional health-related programs, and graduate school. Over the past five years, the acceptance rate for our students applying to medical schools has been 64% (national average is 43.1%). During the same time, 31 students have been accepted into veterinary school. Both the Zoology and Wildlife Ecology (WLE) programs draw significant numbers of competitive students from out of state (78% and 54%, respectively). High percentages of students confirmed for fall 2014 are from out-of-state (78% of 58 students and 50% of 65 students matriculated into the WLE and AVS programs, respectively). Enrollments in Biology, Zoology, AVS, and WLE programs have climbed significantly over the past several years (Figure below). As of November 2013, AVS had 194 undergraduate students, 27% out-of-state. WLE majors numbered 126 and have increased 58% over the past 5 years and 70% in the past 10 years, with recent growth to > 170 matriculated

undergraduate students for fall 2014 (growth of >113% from 2010-2014). The School of Biology and Ecology (SBE), which administers the biology, zoology, and clinical laboratory sciences programs, has seen a 97% increase in undergraduate majors over the past 12 years. Current SBE enrollments are ca. 500 undergraduates, with the majority of students interested in pursuing careers in health sciences. Interest in health-related professions is extremely strong among high school students. In 2013, 19% of college-bound seniors nationwide identified their intended major in the category of 'health professions and related clinical services', with another 7% identifying 'biological and biomedical sciences', according to SAT data.



Applicants to our graduate program in Ecology and Environmental Sciences (EES) and Wildlife Ecology (WLE) have GRE scores higher than many other University programs, reflecting the depth and reputation of our faculty in this area. This initiative will build on this strength and our current reputation in ecological and environmental sciences, climate change, zoology, wildlife ecology, animal sciences, and marine science and aquaculture, and expand it into the emerging academic fields that explore the intersections of these disciplines with animal and public health.

On the management and policy front, this fall the School of Economics (SOE) will be teaching a new course in the Economics of Health in collaboration with health management professionals (e.g., from Eastern Maine Healthcare Systems) and has several faculty focusing on public health issues (e.g., air and water quality, food safety, risk perceptions, health valuation, health communication). SOE has been developing a proposal for an innovative undergraduate degree program in Health Management and Policy that leverages existing courses at UMaine, and at USM (draft curriculum, Appendix A). Once established, this program will also support several health management minors and undergraduate and graduate certificates. Expanding into health-related areas will enhance quality of both our undergraduate and graduate programs, and address the increasing demand for public health and health policy and management-related offerings and degree programs. For examples, currently our nursing program is able to accommodate only a small percentage of the qualified applicants. A public health and health policy and management programs would provide an alternative healthcare related degree program for some of these students. According to the *Bureau of Labor Statistics*, the median income for health care managers is about $89,000/year, and the estimated job growth is 23% over the next decade – much higher than the national average. Many of these jobs and student internships are located in Maine (e.g., several recent SOE students already work at AthenaHealth in Belfast, ME).

Our proposed initiative will result in many positive outcomes for our students, such as increased numbers of student accepted into medical and veterinary schools; increased opportunities for our undergraduate and graduate students to participate in relevant, cutting-edge research; increased numbers of honors projects in this area; increased internship opportunities leading to increased employment opportunities for our students due to their unique knowledge in this important area. All of these translate into an enhanced reputation for the University of Maine and an enhancement of our ability to attract top undergraduate and graduate students to our programs.

3. Advances institutional reputation and recognition a.) through the achievements of its faculty in research, teaching, and service/outreach. An emerging academic area focused on "One Health and the Environment" will synergize with our existing strengths and programs in Climate Change, Ecology and Environmental Sciences, Wildlife Ecology, Zoology, Cell and Molecular Biology, and Animal and Veterinary Sciences, Marine Sciences and Aquaculture, Nursing, Economics and Policy (SOE and SPIA), and the Graduate

School for Biomedical Sciences and Engineering.

Key new faculty focused at the interface of the environment and animal and human health will be able to collaborate with existing faculty and build nationally competitive research programs in emerging critical areas related to climate change effects on animal and human health, emerging infectious diseases, zoonoses, drivers of recent changes in species distributions, and conservation medicine. Innovative health teaching programs that span across ecosystems (managed and natural; marine, terrestrial and fresh water) and organisms (wildlife, domestic animals, and humans) will reflect the emerging holistic approach to animal and human health in an area in which UMaine has the capacity to excel. Because Maine lacks a medical or veterinary school, it is important for UMaine to grow its health science faculty strategically in areas in which they can be nationally competitive and recognized. The focus of this proposal on the interface of changing ecosystems and climate and animal and human health provides a bridge to areas of existing strength. It creates a niche opportunity for success and prominence in health sciences.

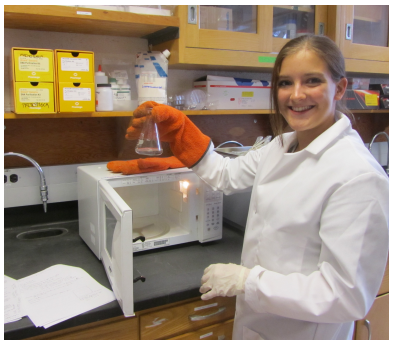
We have direct and established links with state-wide constituencies through the Maine Agricultural and Forestry Experiment Station (MAFES), Cooperative Extension, USGS, Maine Cooperative Fish and Wildlife Research Unit, UM Animal Health Lab, the Maine Departments of Inland Fisheries & Wildlife, SeaGrant, and Agriculture, Forestry & Conservation. With their support, faculty can establish new and expand existing relationships with healthcare interests within the state. Given the breadth of the interests in our state that this initiative will have an impact on, recognition and reputation of our faculty, students, and UMaine will grow.

b.) <u>through the achievements of its graduates.</u> Our current programs in ecology and environmental science, animal science, and wildlife ecology place students throughout the state in employment opportunities. For example, initial employment and professional outcomes were tracked for 118 students who were enrolled in the WLE 455 senior-level co-capstone course from 2007-2013. Of those with known outcomes (75% of the total), 96% were employed in their profession or entered professional or graduate school. Of the 72% of students engaged professionally, 20% were working as wildlife/fisheries biologists, 18% were attending graduate school (3 were pursuing Ph.D. degrees), 17% were working as biological technicians, 10% were working as teachers or environmental educators, and 7% were working in outdoor tourism and recreation. We already have a strong track record with health-related facilities that appreciate the quality of our biology students. The Jackson Laboratory, a world-renown research facility in the genetics of disease, Dahl-Chase Pathology, providing diagnostic services nationwide, Lohmann Animal Health International, creating health solutions for farm animals, and Eastern Maine Medical Center, a major training affiliate for UNE, Maine's only medical school, are among the many health-related businesses that hire UMaine graduates because of the high quality of their training. On the economics and policy side, 7% of SOE alums are currently working in health-related businesses (e.g., Children's Hospital-Boston, Upjohn, United HealthCare, AthenaHealth, Bristol-Myers Squibb, Health Communications Inc., Molina Healthcare, Novartis Animal Health, IDEXX, Oxford Outcomes) or policy (e.g., U.S.H.H.S.). Many of these students are in senior positions (e.g., CFO, CEO, Senior V.P). Investing and building in this area will enable us to increase capacity in our undergraduate and graduate health sciences, management, and policy programs, which will train students for employment opportunities in the health sector, a growing industry in the state. With the depth of our program experience, from research to clinical and internships, our students will be well prepared to enter the workforce.

Many undergraduate students in the One Health umbrella departments conduct research. In the 2013-2014 academic year, SBE, MBS and AVS advisors supervised 86 independent senior capstone projects. Some of these included internships at partner institutions including the Maine Center of Disease Control. Many students with health profession-related academic interests are members of the Honors College. Since 2010 there have been 19-23 honors theses per year among the disciplines relevant to this proposal, with Animal and Veterinary Science, Ecology and Environmental Sciences, Biochemistry, Microbiology, Molecular & Cellular Biology, Biology, Zoology, and Wildlife Ecology faculty advising many honors projects. Developing an honors thesis project allows strong students to distinguish themselves by developing the skills necessary to pose and answer significant questions. Some undergraduate students present papers at scientific meetings and see their data form

part of published journal articles. These experiences prepare them well for graduate or professional programs.

For example, Jordan Gagne (pictured at right), a 2014 graduate of the AVS program and the Honors College, studied 'Prevalence and Species of Lungworms in Maine Moose' and found that the prevalence has increased since 2012, possibly as a result of environmental change. Her research was conducted during her junior and senior years at the UMaine Animal Health Lab, and made possible due to the close interactions of the UMAHL and Maine's Department of Inland Fish and Wildlife. Her work was presented at the North American Moose Conference in Anchorage AK in April, 2014. Jordan graduated with high honors, and will attend vet school at Iowa State University this fall.



4. Demonstrates innovation and/or potential for innovation in instruction and learning experiences. SBE and MBS have invested considerable resources and expertise in innovative teaching methods focused on student-centered and inquiry-based learning. All introductory biology courses now have inquiry-based laboratories and our course management system, *Synapse,* supports early tracking of student progress, multi-media presentations, and a variety of on-line support services, content delivery, and interactive modules. Laboratory-intensive programs put an emphasis on students *doing* science. Laboratory topics emphasize health and the effects of global climate change on health and the environment, and students are asked to suggest and research practical solutions. Our programs in SBE, MBS, AVS, and WLE have a significant number of honors and capstone students working in laboratories and on field projects. There are numerous opportunities for undergraduate research projects at the intersection of ecosystem and climate science and animal and human health. For example, BIO 450 Histology, trains 16-32 capstone students/year in the field of health and environmental influences on health. Each of these students does an independent research project on health and disease. The vast majority of these students go on into the health professions. Similarly, SOE has begun to focus on alternative education models (e.g., flipped classes, 'doing economics') and has successfully implemented an SOE teaching and tutoring lab. Since the lab was started in 2007 grades have improved (A's increased by 25%, B's increased by 1%, C's declined by 8%, and D's declined by 19%, while F's remained constant), which has increased retention of 1st to 2nd year students by 19%.

This initiative will provide opportunities for expansion of recently approved 4+1 programs in Biology and in Economics that provide an accelerated option for a thesis MS degree for high achieving undergraduates. This is particularly relevant for undergraduates going on to professional health programs such as medical school and veterinary school, where an accelerated degree with research experience provides them with a strong and valuable bridge to their professional degrees.

In addition, this initiative will provide opportunity for additional, strong, non-thesis, professional MS programs in animal health, public health, and health management and policy.

5. Reflects a growing synergy of teaching with research and/or service. A significant strength of this proposal is the natural synergy between the components of UMaine's tripartite mission. As Maine begins to confront the problems of climate change, public health problems are already emerging. These will increasingly demand trained professionals in health care, public health, and public safety, as well as research solutions and outreach from academic institutions. UMaine has a critical need to increase our depth of teaching faculty in animal and human health science and policy.

The fabric of education in public health and health policy at UMaine should grow and develop as an interdisciplinary network across academic units. We propose that the *Center for One Health and Environment* build capacity by prioritizing our future faculty hires in disciplines that bridge our research strengths in climate change and ecology and environmental sciences with developing programs and interest in health related sciences and

health economics, management, and policy. That is, as units add faculty, we will search for individuals with expertise across this spectrum of environmental and health sciences.

By spanning the breadth of health from wildlife to domestic animals to humans, and public health and policy, this initiative creates a collaborative web of health scientists on campus addressing the same types of issues in different organisms that naturally blends with ecosystem sciences and policy. Many animal and public health issues are interrelated and responding to common climate and environmental drivers. As a result, critical concerns facing constituencies in the state are common across traditional disciplines. This provides opportunities for cross-departmental instruction addressing the needs of students in a number of degree programs. Support for this initiative will enable student and faculty, through internships and collaborative projects, to increase outreach activities related to the health challenges that arise as our climate and ecosystems change. Long-range goals to develop a climate-focused masters program in public health can guide incremental growth in faculty expertise. There are immediate needs for expertise in health policy, biostatistics and epidemiology, specialties that will be required for ultimate accreditation of a graduate public health degree program.

Appendix A. Public Health Management and Policy

Fall	Spring
BIO 100 – Basic Biology (4 cr.)	BIO 208 – Anatomy and Physiology (4 cr.)
MAT 115 – Applied Math for Business and Economics (3 cr.)	MAT 232 – Principles of Statistical Inference (3 cr.)
SOC 101 – Introduction to Sociology (3 cr.)	1XX - Introduction to Health Science (3 cr.)
ENG 101 – College Composition (3 cr.)	CMJ 103 – Fundamentals of Public Communication (3 cr.)
NFA 117 – Issues and Opportunities (1 cr.)	FSN 230 – Nutritional and Medical Terminology (1 cr.)
Total Credits: 14	Total Credits: 14

Fall	Spring
BMB 207/209 – Fund. of Chemistry Lect and Lab (3cr. & 1cr.)	BMB 240/241 – Microbio for Prof Nurse Lect and Lab (3cr. & 2cr.)
BUA 201 – Principles of Financial Accounting (3 cr.)	BUA 202 – Principles of Managerial Accounting (3 cr.)
FSN 101 – Introduction to Food and Nutrition (3 cr.)	INT 200 – (SBE) Orientation to Health Professions (4 cr.)
PHI 235 – Biomedical Ethics (3 cr.) (W,S,E)	ECO 121 – Principle of Macroeconomic (3 cr.)
ECO 120 – Principles of Microeconomics (3 cr.)	
Total Credits: 16	Total Credits: 15

Fall	Spring
NUR 303 – Pathophysiology (3 cr.)	General Elective (Art) (3 cr.)
FSN 270 – World Food and Nutrition (3 cr.) (C,P)	SWK 440 – Social Welfare Policy and Issues (3 cr.)
ECO 3XX - Financial Management in Health Care	ECO 342 – Health Economics and Policy (3 cr.)
BUA 235 – Info Systems and Technology for Business (3 cr.)	BIO 350 – Concepts and Applications of Genetics (3 cr.)
Professional Elective (3 cr.)	CMJ 420 – Health Communication (3 cr.)
Total Credits: 15	Total Credits: 15

Fall	Spring
KPE 425 – Health Promotion and Disease Prevention (3 cr.)	4XX – Health Management Internship (16 cr.)
Professional Electives (12 cr.)	
Total Credits: 15	Total: 16

Possible electives:

ANT 260 - Forensic Anthropology
CMJ 425 - Health Campaigns: Service Learning
BIO 307 – Neuroscience
BIO 377/378 – Medical Physiology
BIO 335 – Human Anatomy
BIO 336 – Developmental Biology
BIO 450 – Histology
BMB 110 – Plagues Past and Present
BMB 300/305 Microbiology
BMB 420 – Infectious Disease
BMB 440 – Immunology
ECO 377 - Introduction to Natural Resource Economics & Policy
ECO 4XX - Health Care Administration and Policy
ECO 4XX - Health Care System Management
ECO 450 – International Environmental Economics and Policy
ECO 488 – Managerial Economics
FSN 401 - Community Nutrition
FSN 436 - Food Law
GRN 503 - Health Policy Issues of an Aging Population
INT 479: Methods in Epidemiology
KPE 383 - Organization and Administration in Athletic Training
KPE 483 - The Comprehensive School Health Program
NUR 365 - Healthcare Infomatics
NUR 415 - Socio-Cultural Issues in Health and Health Care
NUR 693 - Ethical Inquiry in Health Care
NUR 694 - Health Policy, Politics and Practice
MPH 400 Introduction to Public Health*
MPH 425 American Health System*
MPH 555 Environmental Health*
POS 282 - Introduction to American Law
POS 241 - Introduction to Comparative Politics
POS 352 - American Public Opinion
SOC 201 - Social Inequality
SOC 202 - Social Problems
SOC 314 - Law and Society
SOC 371 - Immigration, Women and Society
SWK 320 - Introduction to Social Work
WGS 230 - Women, Health, and the Environment

TABLE 1: Degree Programs and Courses Related to Ecosystems and Health				
Degree Programs	**Vital Statistics**	**Relevant Courses**	**Faculty**	**Relevance**
School of Biology & Ecology				
Biology Botany Clinical Laboratory Sciences Zoology	#Students: UG: 521 G: 48 SCH: 10,694 FTE: 5.7	BIO100: Basic Biology	Lect. Dr. Dastoor	Introduction to ecological systems and basic cellular / molecular structures and mechanisms
		BIO200: Biology of Organisms	Lect. Dr. Dastoor, Asst. Prof. Olsen	Anatomy and physiology of plants + animals; Required: pre-med/vet, wildlife, zoo majors
		BIO 208: Anatomy and Physiology	Assoc. Prof. Kass	Functions of the human body and what processes cause various pathologies in animal and human health
		BIO 310: Plant Biology	Assoc. Prof. Annis	Introduction to plants, their roles in local ecosystems & significance for humans/animals
		BIO 326: Introductory Entomology	Prof. Groden	Includes units on insect vectors of disease, climate change impacts of insect populations, and invasive insects
		BIO 329/331: Vertebrate Biology	Prof. Kinnison	Anatomy, life histories and evolutionary relationships of vertebrates
		BIO 336: Developmental Biology	Prof. M. Tyler	Development of animals, cancer, and stem cell biology. Effect of the environment on development and disease
		BIO 350: Introduction to Genetics	Asst. Prof. Smith	Includes genetic mechanisms of human and animal diseases, and understanding relative impact of the environment on phenotype
		BIO 353: Invertebrate Zoology	Prof. S. Tyler	Includes weekly discussions on issues w/invertebrates: effects of climate change, ocean acidification, and pollution on commercially important invertebrates
		BIO 377/378: Medical Physiology	Assoc. Prof. Kass	Functions of the human body and what processes cause various pathologies in animal and human health
		BIO 391/597: Experimental Ecology	Prof. Kinnison, Prof. Holberton	Advanced experimental approaches to ecology, potentially including population and community interactions tied to health/disease
		BIO 405: Clinical Lab Methods in Infectious disease	Unassigned	Introduction to clinical methods for identifying human diseases for the medical lab scientist
		BIO 430: Ecology and systematics of aquatic insects	Asst. Prof. Greig	Influence of climate change on aquatic insect disease vectors and host-parasite interactions
		BIO 432: Introduction to Fungi	Assoc. Prof. Annis	Introduction to fungi, their roles in various ecosystems with an emphasis on Maine
		BIO 433: Mammalogy	Adjunct	Physiology and ecological community effects of mammals with discussion of climate change effects
		BIO 434: Avian Biology & Ecology	Asst. Prof. Olsen	Physiology, migratory movements, and ecological community effects of birds with discussion of climate change effects
		BIO 450: Histology	Prof. M. Tyler	Microscopic anatomy and function of animal tissues and organs, main focus is environmental effects on health
		BIO 455/555: Biological Invasions	Prof. Alyokhin	Ecological, economic, and social impacts of non-native species in a changing world
		BIO 462: Genetics	Prof. de los Reyes	Genetic & epigenetic mechanisms of human, animal & plant diseases; Required: pre-med, pre-vet and other allied medical professions preparatory programs

		BIO 463: River Ecology	Asst. Prof. Greig	Organism responses to climate change; influence of temperature on aquatic host-parasite interactions
		BIO 464: Taxomony of Vascular Plants	Prof. Campbell	The primary focus of the course, identification of major taxa of vascular plants, provides a skill that is useful in determining shifts in the flora related to climate change
		BIO 476: Paleoecology	Asst. Prof. Gill	Ecological responses to global changes in the past and how that can be relevant to understanding current and future change
		BIO479: Vertebrate Endocrinology/Behavioral Endocrinology	Prof. Holberton	Basic principles of vertebrate endocrinology, including development, growth, reproduction, movement, environmental health and endocrine disruption
		BIO 480: Cell Biology	Prof. Kass	Functions of various cell types underlying various pathologies in animal and human health
		INT482: Pesticides and the Environment	Prof. Alyokhin	Effects of global change on pesticide use, including implications for human health.
		BIO /ANT 501: Climate, Culture, and the Biosphere	Asst. Prof. Gill, Assoc. Prof. Zaro	Overview of human evolution, climate and environmental change from 2 million years ago to the present
		BIO511: Insect Ecology	Prof. Drummond, Prof. Alyokhin	Insects in changing ecosystems, including economically important pests, vectors, and beneficials.
School of Economics				
Ecology & Environmental Science Economics Financial Economics Resource Economics & Policy	# Students: UG: 130 G: 27 SCH: 8,000 FTE: 10.44	ECO 120: Principles of Microeconomics	*Unassigned*	Microeconomics and their application to economic issues and problems
		ECO 121: Principles of Macroeconomics	*Unassigned*	Macroeconomics and their application to modern economic issues and problems
		ECO 254: Small Business Economics & Management	*Unassigned*	Economic concepts to real world business and economic decisions
		ECO 3XX: Financial Management in Health Care	*Unassigned*	Financial theory and management principles and concepts in health care
		ECO 342: Health Economics	Prof. Breece	Economic principles to examine health policy issues
		ECO 377: Intro to Resource Economics and Policy	Asst. Prof. Noblet	Economic aspects of environmental problems and policies
		ECO 4XX: Health Care Administration & Policy	*Unassigned*	The administration and management of health care organizations
		ECO 4XX: Health Care System Management	*Unassigned*	Examines the public/non-profit/for-profit health care system in the US
		ECO 450: International Environment Econom & Policy	Prof. Teisl	Economics and processes of international policy development
		ECO 488: Managerial Economics	Prof. White	Quantitative techniques for managerial decision making
		ECO 582: The Human Dimensions of Global Change	*Unassigned*	Study of human role in environmental change, the social consequences and policy options
School of Food & Agriculture				
Animal and Veterinary Sciences	#Students: UG: 169 FTE: 3.55 SCH: 2,330	AVS 145: Animal Science	Assoc. Prof. Wallace	Fundamental principles of animal science
		AVS 211: Introduction to Aquaculture	Asst. Prof.Bowden	Aquaculture systems and species including health issues
		AVS 240: Laboratory and Companion Animal Science	Assoc. Prof. Causey	Care of rodents, rabbits, dogs & cats including welfare, husbandry, uses, diet and health maintenance

		AVS 349: Livestock Management	Assoc. Prof. Wallace	Feeding, care and management of beef cattle, sheep and swine
		AVS 401: Senior Paper in Animal Science I	Prof. Stokes	Original investigation proposal
		AVS 402: Senior Paper in Animal Science II	Prof. Stokes	Original investigation-data gathering and interpretation
		AVS 433: Equine Exercise Physiology	Assoc. Prof. Causey	Metabolic and physiologic factors associated with exercise and training the horse
		AVS 437: Animal Disease	Assoc. Prof. Weber	Causes, pathology and control of diseases of domestic animals
		AVS 455: Animal Nutrition	Prof. Stokes	Basic principles of animal nutrition
		AVS 480: Physiology of Reproduction	Assoc. Prof. Wallace	Comparative development and functions of the reproductive process in domestic animals
Department of Molecular and Biomedical Sciences				
Biochemistry Microbiology Molecular & Cellular Biology	# Students: UG: 124 G: 69 SCH: 5,360 FTE: 9.3	BMB 110: Plagues Past and Present	*Unassigned*	Nature of epidemics of infectious disease in past and emerging
		BMB 280: Intro Molecular & Cellular Biology	Asst. Prof. Sher	Temperature-regulated gene expression
		BMB 300: Microbiology	*Unassigned*	Introduction to infectious microbes
		BMB 420: Infectious Disease	Asst. Prof. Wheeler	Advanced work on pathogens and epidemiology
		BMB 440: Immunology	*Unassigned*	Relationship of climate change to human and animal immunity
		BMB 455: Virology	*Unassigned*	Molecular aspects of emerging viral diseases associated with climate change
		INT 479: Methods in Epidemiology	Asst. Prof. Sher	Introduction to epidemiology, crucial in study of human disease
Department of Wildlife, Fisheries and Conservation Biology				
Wildlife Ecology	# Students: UG: 126 G: 22 SCH: 1,184 FTE: 0.75	WLE 323: Introduction to Conservation Biology	Prof. Hunter	Discusses changing climates as stressors of plant and animal populations
		WLE 450: Wildlife-Habitat Relationships	Prof. Harrison	Senior capstone course, major component focused on effects of changing climate on species distribution
Department of Anthropology				
Anthropology Anthropology & Environmental Policy		ANT 210: Introduction to Physical Anthropology	Res. Assoc. Prof. Sorg	Environmental physiology and adaptation
		ANT 260: Forensic Anthropology	Res. Assoc. Prof. Sorg	Disaster response and death investigation