[1]Environmental science: One perspective on what to study and what it means

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In this paper I suggest a way in which students can think about how to decide what they want to study or what they want for a career. Then I describe how I see environmental science in light of this view and from the perspectives I used in making my own decisions to enter this field. Finally, I conclude with a description of the Department of Environmental Science & Policy (ESP) at the University of Southern Maine as one embodiment of an interdisciplinary applied approach.

Environmental scientists, naturalists, and others like to use dichotomous ("two equal parts") keys to identify plants, insects, and animals. For example, suppose we have a tree and we want to see what it is. If we pick out different trees in a tree book and compare them to our tree it might take quite a long time to hit upon the actual tree and we would hope the actual tree is in the book. A dichotomous key instead has us compare a characteristic that can have only one of two outcomes; something that we can fairly easily decide: yes or no. We continue with a pattern of yes-no decisions based on our answers. For example, a first question might be whether the tree has needles (actually, a type of leaf) or "regular" leaves—something that usually easy to decide. If our answer is yes to needles, then the key leads us to a second question of whether the needles occur individually or in bundles. If in bundles, are they in groups or three or not. If not in groups of three, are they in groups of five, if not in groups of five, are they in groups of two or not. If in groups of two, are the needles short or long (seven or more cm)? If yes, you have a red pine (*Pinus resinosa*) as the result of a series of characteristics that have gradually narrowed down the range of species. There are over a hundred species of pine, so constructing such a key has to be done with care, and is best tailored for specific regions.

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Since a dichotomous key is designed to make a hard task easier, why not use it to pick a career? How might this work? Well this means you don't have to select individual careers and make a yes/no decision or compare each and every occupation. Instead you could make yes/no decisions about the characteristics of working conditions or preferences you have and then see where that brings you. For example, do you like to be inside or outside? If you like to be inside, would you rather be in a laboratory or an office? If you would prefer to be outside, would you like to be in the city or out in the country? If out in the country would you prefer the land or the water? Another question might be "Do you like to work on one task or project for a long time or would you rather do many smaller projects," or "Do you like to work by yourself or as a team member in a group?" Even if there is not a dichotomous key that leads to a specific job type, the answers can be collected into a series of characteristics that help a person determine what attributes of a job are most appealing.

I applied this approach in making my own career decisions, but there was not just one occupation resulting at the end of the experience. Instead, I had a series of traits based on my answers that gave me something to compare. Environmental science is such a broad, varied area of study that it allows for multiple orientations. At first I was concerned that I did not have a clear occupation in mind nor even one particular subject or topic. I liked a little of everything. I liked being outside and I liked being inside. I liked working by myself and I liked working with others. I liked large projects and I liked multiple small ones. So I thought of another approach, one based on a mental orientation. For example, some people tend to look at large-scale or big-picture things. Others like little details.

At the ecosystem level of study, a big picture view is useful because it reflects how an ecosystem functions as a series of interacting components. A broad approach or view in science is sometimes referred to as "holism." In contrast, breaking something down into its components is "reductionism." Much of science has traditionally reflected a reductionistic approach. One of the many things I like about environmental science is that it incorporates both holism and reductionism—both are

necessary in understanding and addressing environmental problems. This is due to the complexity and interdisciplinarity of environmental problems and it is due to the fact that just about everything has an environmental aspect of some kind or another.

Students who like a variety of academic subjects (or who, like me, had a hard time picking just one major) can really benefit from the variety encompassed in environmental science. There are people aspects to it, physical science aspects, and life science aspects. Economics is a factor as is political science, sociology, history, geography, and archaeology. But so are geology, chemistry, physics, and of course, biology. Not only are so many traditional academic subjects involved, but so are applied subjects like public policy, environmental planning, sustainability, and energy, not to mention broad applications of technology, engineering, and mathematics. A person can go in a great many directions within the general realm of environmental science. Someone who likes multiple subjects can have a career where this is an asset rather than a liability.

In the United States, environmental science programs arose out of a multi- and interdisciplinary tradition. There are three main origin pathways (Table 1)—that of a traditional discipline such as biology leading to an area of emphasis that becomes environmental science, a collaborative origin from multiple subject areas (my own department was created by representatives of economics, chemistry, biology, geology, geography, and political science), and true "new births" where environmental science is a fresh creation not stemming from pre-existing departments and academic subject areas.

Table 1. Three origins of environmental science/studies departments

Daughter cell	Product or descendent of a particular department or discipline. Typically, Biology or Geology
Step child	Descended from multiple academic departments.
New creation	Independent. Not from any one or multiple departments.

As a result of the relatively recent creation of environmental science departments and their interdisciplinary natures, the review or accreditation of them in the United States only occurs at either a very broad level or as a purely voluntary peer review. There are of course, regional accrediting bodies for academic institutions themselves, but there is no one accrediting body for environmental science or environmental studies. My department participates in the North East Environmental Studies (NEES) group, a loose affiliation of schools in and around New England that meet annually to discuss higher education environmental science and environmental studies curriculum). We also looked at the National Association of Environmental Professionals (NAEP, which is considering some sort of environmental science/studies department review but not a formal accreditation. As that develops, we may become a participant. We belong to the Interdisciplinary Environmental Association (http://ieaonline.org/), and attend its

conferences when they appear on the east coast. We also formed a student honor society chapter of this association. And we participate in SENCER (Science Education for New Civic Engagement and Responsibility, (www.sencer.net/), an international association of scholars and academic units applying the science of learning to the learning of science.

Our department was established in 1995 as the Program in Environmental Science & Policy. It offered a Bachelor of Arts (BA) in four concentrations: applied ecology, water resources, community planning, and environmental policy. At first we converted the concentrations in applied ecology and water resource to a Bachelor of Science (BS) degree and kept the community planning and environmental policy options as a BA. In 2004 we combined the two concentrations in each degree so now there is one BA in Environmental Planning and Policy and one BS in Environmental Science. In 2014, we created a 3/2 program with the Muskie School's graduate (master's) program in Policy, Planning, and Management, enabling a student to work toward the BA for the first three years of college, spend their fourth year taking courses that serve both the BA and the Master's degree, and finish up the Masters by the end of their fifth year (a year less than the normal six years for both).

We are fairly small, giving our students one-on-one attention. About 10 to 15 students graduate each year and there are usually 130 to 150 majors. Historically, students tend to divide fairly evenly between the BA and BS. Our department is small too, with five full time faculty members and several adjunct part-timers.

Our primary mission is to provide an interdisciplinary environmental education experience that integrates science, policy, and practice, and that will prepare students for employment, graduate school, and professional certification in environmental science, environmental policy, community planning, or teaching. We support this mission through faculty training and research and by offering degree concentrations and courses that integrate knowledge of the natural, physical, and earth sciences with awareness and understanding of institutional and community decision-making processes through the social sciences. To this end, we promote learning beyond seat-based classroom instruction and includes internships, service to community, and independent research. The department awards minors in Environmental Sustainability, Applied Energy, Environmental Science, Environmental Policy, , and Nature Tourism (the latter in conjunction with the Department of Recreation and Leisure Studies). The department has certificate programs in Applied Energy, Environmental Policy Analysis, and Environmental Education.

The BS degree in Environmental Science is designed to prepare students either for graduate school or for immediate employment federal, state, and local government agencies or with private sector nonprofit organizations. Environmental science students focus on water resources and/or applied ecology. Students studying Water Resources focus on the flows and quality of water in various environments including streams, lakes, aquifers, and soils, while receiving comprehensive training in the biology, chemistry, and ecology of soils and water bodies. The focus is on human-influenced and natural processes affecting soil quality and water quality. Courses emphasize watershed hydrology, water quality assessment and control, soil and water conservation, , and watershed management and planning. Students are often involved in faculty research programs, and present the results of their research at state and national conferences.

Applied Ecology is the study of interrelationships between organisms and their environment, within the context of seeking to understand and mitigate the impacts of human activities on those systems. Students are provided with the core science background necessary to conduct environmental field and laboratory research. Students then gain familiarity with specific ecological systems, concepts and methods through courses such as Water Quality Assessment, Forest Ecology, Wetlands Ecology, Field Systems Ecology, Limnology, and Entomology.

Applied ecology courses are laboratory- and field-intensive and quantitative, a major goal being the acquisition of advanced skills in utilizing analytical tools – such as statistical software, mapping applications with geographic information systems (GIS). This combination of a strong science core with applied environmental technologies allows an Environmental Science graduate to pursue either graduate study in the sciences or immediate entry-level employment with an environmental engineering firm, government agency or non-governmental organization. Information on this program and the department is found at http://usm.maine.edu/environmental-science.

The BA degree in Environmental Planning and Policy combines two disciplines in recognition of their inherent interconnection in conjunction with our basic environmental science core courses. The degree is designed to prepare students for graduate school and as future leaders for careers in federal, state, and local government; the private sector; nonprofit organizations; and citizen advocacy groups. Many of our graduates have immediately entered professional positions in landscape design, regulatory compliance, land-use or community planning, urban renewal, environmental consulting, environmental education, and as environmental technicians.

We seek to educate individuals who contribute to solving environmental problems, making public and private institutions more responsive to the social and economic needs of communities, and by moving toward a more environmentally sustainable society. We take an evidence-based approach to the teaching and learning of environmental science. Our curriculum emphasizes application as well as theory by focusing on real problems and projects affecting the region. The opportunity to gain practical planning and policy experience is also provided to our students through their participation in field-based courses and an internship.

The *environmental planning* aspect of the degree is intended to introduce students to the foundations of community, natural resource, and sustainable planning. Through a series of core courses, students examine the spatial and non-spatial aspects of environmental problems. The *environmental policy* aspect trains students on policy development, formulation, analysis, and implementation, through in-depth examination of policy science, environmental risk assessment, toxicology, environmental impact analysis, and environmental economics. Students also can tailor their area of study on a particular topic of interest such as pollution, natural resource management, international policy, or energy. Students who choose the planning and policy option do well in the job market, typically finding a position in their chosen field within the year they graduate.

To increase the practical skills of our students, we created an "energy house" by converting a 19th century residential structure on the Gorham Campus. This department-wide initiative also reaches out to other faculty and institutions.

The environmental fields have proven themselves to be steady aspects of the employment market. Environmental engineers are placed among the top ten fastest growing jobs over the next ten years. The U.S. Bureau of Labor Statistics has placed environmental science and protection technicians, including health and safety, among the fastest growing occupations between 2006 and 2016.[2]

ESP graduates find employment in many environmental settings, including federal, state, and local government; environmental and civil consulting and engineering, environmental education and teaching, private industry ranging from healthcare to semiconductor manufacturing, applied research, environmental advocacy, and community planning (Table 2).

Environmental Planning and Policy majors pursue careers in community planning, land use regulation, environmental enforcement, compliance, advocacy, education, and many related areas. Environmental Science majors pursue careers in environmental research, environmental compliance, construction & development, laboratory analysis, and education. Educational overlap of the two majors lead to many crossing over in their careers; a planning person might be in a science job and an environmental science graduate might be working in community planning. For example, one of our policy graduates is an air quality technician for the National Park Service.

[2] http://www.bls.gov/ooh/life-physical-and-social-science/environmental-science-and-protection-technicians.htm

Table 2. Recent department graduate placements	
Company	**Title of position**
Aerogrow Boulder,CO	Horticulture Technician
Americorps (2)	Environmental Educator
United States Air Force	Pilot
Analog Devices Inc. Norwood, MA	Environmental Safety & Health Engineer
Greater Portland Council of Governments Portland, ME	Alternative Transportation Planner
Acheron Engineering Services Newport, ME	Soil and Wetland Scientist
Biodiversity Institute Gansevoort, NY	Biology Technician
Blackstone Consulting Portland, ME	Environmental Consultant
Boyle Associates South Portland, ME	Wetland Scientist
Casella Waste Systems Rutland, VT	Biosolids Specialist
Division of Air Quality and Environmental Management Clark County, NV	Environmental Scientist
Clean Harbors Environmental Services Portland, ME	Hazardous Waste Technician, Environmental Safety and Health Specialists
Coastal Enterprises Inc. Wiscasset, ME	Water Quality Specialist
Connecticut	Town planner
Contech (6) West Chester, OH	Storm Water Management Scientists
Cumberland County Soil and Water District Cumberland County, ME	Education Coordinator
Delorme Yarmouth, ME	GIS Technician
Department of Health and Human Resources NH	Air Quality Specialist
Devine & Tarbell Portland, ME	Regulatory Specialist
Eco Maine (2) Portland, ME	Recycling Coordinator
United States EPA	Environmental Scientist
Fletcher Allen Health Care Burlington, VT	Environmental Safety and Health Specialist

Florida Light and Power Statewide, FL	Dam Removal Monitor
General Electric National, USA	Environmental Safety and Health Specialist
City of Syracuse, NY	GIS Technician
Goldman Environmental Consultants Braintree, MA	Environmental Field Technician
Great Salt Bay Sanitary District Damariscotta, ME	Treatment Plant Manager
Hannaford (2) ME, NY	Locally Grown Foods Coordinator
U.S. Dept. of Homeland Security	Marine Corps Supervisor
IDEXX Portland/Gorham, ME	Chemist
International Paper Bucksport, ME	Environmental Safety and Health Quality Manager
Lawyer (3)	Environmental Lawyer, General Law
L.L. Bean Freeport, ME	Environmental Safety and Health Specialist
Mactec Engineering and Consulting Alpharetta, GA	Environmental Scientist
Maine DEP Statewide, ME	Water Quality Specialist
Matt Laboratories, CA	Environmental Chemist
Merrill Lynch New York, NY	Financial Planner
Moyes Environmental	Soil Scientist
National Parks Service National, USA	Ranger, Air Quality Technician
NE Interstate Water Pollution Control Commission	Environmental Educator
NOAA, National Marine Fisheries Service	Marine Scientist
Peace Corps; 2	Water Quality Volunteer
Physics Solutions	Engineer
City of Woodstock Woodstock, CT	City planner
Vermont	Town planner
Poland Springs (3) Hollis/Poland, ME	Safety and Compliance Specialist, Environmental Scientists
Portland Water District Portland, ME	Environmental Scientist, Environmental Educator, Environmental Education Coordinator
Portsmouth Naval Ship Yard Kittery, ME/ Portsmouth, NH	Environmental Safety and Health Specialist
Ransom Environmental	Environmental Technician

Portland, ME	
SAPPI Westbrook/Skowhegan, ME	Environmental Safety and Health Specialist
City of Somersworth, NH	City Planner
City of South Portland, ME	City Planner
TRC Environmental Consulting Lowell, MA	Environmental Scientist
Wells Estuarine Research Reserve Wells, ME	GIS Specialist
Trinity Services	Project and Field Services Coordinator
Education (11)	Middle & High school Science Teachers

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