A SEARCH FOR IDENTITY: EXPLORING CORE COMPETENCIES FOR INTERDISCIPLINARY ENVIRONMENTAL PROGRAMS

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THE INTERDISCIPLINARY ENVIRONMENTAL PROGRAM IDENTITY CHALLENGE

The Challenge

In 2003, the National Science Foundation Advisory Committee for Environmental Research and Education's (AC-ERE's) report, *Complex Environmental Systems: Synthesis for Earth, Life and Society in the 21st Century,* stressed the importance of developing innovative interdisciplinary research and educational approaches to train environmental scientists, policymakers and professionals.

> Because of the complex relationships among people, ecosystems, and the biosphere, human health and well-being are closely linked to the integrity of local, regional, and global ecosystems. Therefore, environmental research and education are central elements of local, national, and global security, health, and prosperity (Pfirman and the AC-ERE 2003, 1).

Subsequent AC-ERE reports—*Complex Environmental Systems: Pathways to the Future* (2005) and *Transitions and Tipping Points in Complex Environmental Systems* (2009)—continue to underscore this urgency. The 2009 report urges a shift toward societal needs-driven research exemplified by the emerging field of sustainability science, an interdisciplinary approach to understanding the complex interaction of social and natural systems. The report also stresses the need for higher education programs that prepare students as interdisciplinarians.

Both environmental degree programs and environmental careers have experienced dramatic growth since 2000. About a quarter of the more than 1200 interdisciplinary environmental (IE) degree programs in the United States were established in the last decade, and approximately two-thirds since 1990. The majority of programs also report increasing enrollment levels, a trend that appears to be accelerating (Vincent 2009). New careers in environmental sustainability have arisen since 2000 while growth also continues in traditional careers in both industry and government (*Environmental Business Journal* 2007). The U. S. Department of Labor (2008) predicts a 25% increase in environmental scientists and specialists positions by 2016. In addition to increased market demand, federal agencies recognize the challenge of replacing large numbers of employees expected to retire soon (U. S. Environmental Protection Agency 1999) while also transitioning federal environmental research and protection programs toward integrated systems approaches to sustainability (U. S. Environmental Protection Agency 2007).

This past decade also witnessed the formation of the National Council for Science and the Environment (NCSE), a non-profit organization dedicated to improving the scientific basis of environmental decision making, and the Council of Environmental Deans and Directors (CEDD), an association of more than 150 environmental academic program leaders facilitated by the NCSE as a part of its University Affiliate Program. One of the primary goals of the CEDD is to determine the essential core competencies for graduates of IE degree programs. IE programs have flourished in higher educational institutions across the United States for four decades (for a discussion of program origins see Schoenfeld 1979, Weis 1990, Soule and Press 1998). Despite this long history and the large and growing number of programs, no consensus has emerged on shared program identity, core principles, or interdisciplinary structure. Key questions remain concerning IE programs' educational mission, scope and content, core competencies for graduates, and assessment guidelines (Caldwell 1983, Soule and Press 1998, Blockstein and Greene 2003, McGowan 2004).

Environmental studies and science is a virtually unbounded field of study, as exhibited in the wide variety of IE degree-granting programs. Shaped by the traditions, missions and cultures of their host institutions as well as their participating faculty and other stakeholders, extensive variability is found in their disciplinary foci, educational goals, curricular content, and institutional placements. Moreover, IE programs, perhaps more than any other area in higher education, are constantly evolving to address emerging issues and prepare graduates for new careers. New programs are being established and existing programs frequently change in response to shifting political and social environments, funding opportunities, and advances in technology and knowledge. This dynamic diversity contributes to a "healthy environmental studies ecosystem" (Schoenfeld 1979).

However, the lack of consensus on field identity, core curriculum, and interdisciplinary pedagogy fuels criticism that IE programs lack rigor, sustains vigorous debate about program design assessment, and contributes to confusion about the competence of graduates. Caldwell (1983, 249) argues that "if environmental studies are to be accorded a status commensurate with their significance for mankind and the biosphere," scholars must determine what constitutes the environmental studies "metadiscipline." Sherren (2007) contends that programs may easily be perceived as "anything goes." Braddock, Fein and Rickson (1994) claim that misperceptions among the public, students, and employers about what to expect from environmental programs can create negative perceptions within university and college administrations that undermine support for IE programs (see also O'Reily, Deegan and Columbo 1996; Fridgen 2005). Soule and Press (1998) and González, Neimeier and Navrotsky (2003) observe that reduced visibility and credibility among decision-makers and funding entities can negatively affect research and funding opportunities. Soule and Press (1998) argue that a distinct identity is needed to avert "crises of vision and curricular development," which lead to "planning paralysis," "hyper-diverse and shallow curricula," and "multidisciplinary illiteracy." These criticisms undermine program legitimacy.

The only existing core competency guidelines for IE programs consist of benchmark recommendations for honors graduates of United Kingdom undergraduate environmental degree programs (Eastwood and Blumhof 2002). The benchmark document, *Academic Standards for Earth Sciences, Environmental Sciences and Environmental Studies,* includes recommendations on key skills as well as subject-specific and generic knowledge for United Kingdom undergraduate programs in earth science, environmental science and environmental studies (Quality Assurance Agency for Higher Education 2000).

Addressing the Challenge

In response to the criticisms, and given the lack of comprehensive empirical studies on IE program curriculum design and the career paths of program graduates, the CEDD launched research projects to explore the potential for reaching consensus on core competencies to guide the curriculum design for IE programs and to investigate the relationship between academic programs and graduate careers. Together, the findings of these two studies will provide a framework for understanding IE program curricula at colleges and universities in the United States.

The Campus to Careers study was designed by Dr. Richard Freeman, Herbert Ascherman Chair in Economics at Harvard University, and is a joint project of the National Bureau of Economic Research, the Harvard Science and Engineering Workforce Project and the CEDD. The first pilot round of this study has been completed and a second round is currently underway. Information about the study is available on the CEDD website at http://www.ncseonline.org/CEDD/.

The first two phases of the CEDD Curriculum Study comprise the research described herein. These two phases represent the first national empirical study designed to help resolve the issues of field identity and core competency criteria for IE programs. The first phase was a Q methodological study to discern the views on environmental program curriculum design held by leaders of U. S. environmental programs. Q methodology has been used to identify perspectives on a variety of issues, providing insight into the characteristics of each perspective and making explicit areas of consensus and conflict.

The second phase was a comprehensive online survey of United States IE program administrators conducted during January-May 2008. The survey was aimed at program administrators not only because they have detailed knowledge of their IE degree programs but also because less than half of these programs have their own core faculty. The survey findings provide a comprehensive picture of IE programs themselves as well as administrators' views on program structure and curriculum design. The survey's goals were: (1) identification of all U. S. programs that award IE degrees along with relevant features of their host institutions, programs and degrees; (2) identification of potential core knowledge and skill competency areas; (3) identification of ideal curriculum types; (4) elucidation of the relationships between ideal curriculum types and institutional, program, and degree features; (5) identification of influences on programs and trends in curriculum evolution; and (6) provide a baseline data set for subsequent longitudinal study.

The first two phases of the curriculum study focus on four broad research questions designed to inform and facilitate discussion on core competency criteria.

1. What are the perspectives among IE program leaders regarding curriculum design? What do they have in common and how do they differ?
2. What dimensions underlie the inclusion of various knowledge and skill areas in IE program curricula? How are these areas related and how may they be combined into interdisciplinary core competency areas?
3. What types of ideal curriculum models of IE program curricula exist? What are the characteristics of each model?
4. How are administrative and degree program features related to ideal curriculum types? What do these relationships indicate concerning program structure and evolution?

A planned future third phase of the CEDD Curriculum Study will involve two investigations: the first on model programs and the second on curriculum convergence. In the model program investigation, information from the survey will be used to identify successful programs that best represent ideal curriculum models and conduct an in-depth study of curriculum elements and structure. The curriculum convergence investigation will look at changes in curriculum design and program administration among programs established before 1990 to determine whether curricula are converging on one or more models, are diverging, or are trending in no particular direction.

The results of the first two phases of the curriculum study provide a framework for understanding environmental program curricula at colleges and universities in the United States. This understanding is used by higher education institutions establishing new IE programs and by existing programs in their strategic planning, curriculum revision and program review processes Ultimately, the findings, along with the findings of the third and final phase of the CEDD Curriculum Study and the CEDD Campus to Careers study, will be used to inform a national dialogue and conference to facilitate discussion on core competency areas that can form the basis of a consensus on curriculum design and perhaps eventually to guidelines for program certification or accreditation.

CHAPTER II

INTERDISCIPLINARY ENVIRONMENTAL PROGRAM IDENTITY AND CORE COMPETENCIES: A REVIEW OF THE LITERATURE

Interdisciplinary Environmental Program Evolution

IE degree programs and environmental careers in the United States have both enjoyed rapid, albeit uneven, growth since the mid-1960s. Along the way, programs and careers have evolved in response to internal influences within the universities and colleges hosting programs and to external forces including sociopolitical changes and the economy.

The roots of environment programs in the United States can be traced to the conservation and preservation philosophies of the late nineteenth and early twentieth centuries. The conservation movement championed by individuals such as John Wesley Powell, the first director the U. S. Geological Service, and Gifford Pinchot, the first chief of the U. S. Forest Service, catalyzed the institutionalization of natural resource conservation and management academic fields such as forestry, fisheries, and wildlife management. This focus on the prudent use of natural resources dominated environmental academic programs until the emergence of the modern environmental movement in the 1960s.

The first environmental studies programs with a multidisciplinary, problem-oriented approach sprang up in colleges and universities during the late 1960s and early 1970s in response to public concerns about pollution and its effects on health, nature and quality of life (Schoenfeld 1979, Weis 1990, Soule and Press 1998). This generation of environmental programs occupied a unique place in higher education due to its embodiment as “a social movement anchored in academia” (Soule and Press 1998, 397), restructuring of traditional education to focus on the *interrelationships* among disciplinary knowledge, and natural tilt toward advocacy based on the need for social transformation (Rest 2002). Soule and Press (1998) identified three foci of these early programs: environmental science (physical and life sciences and sometimes applied science), environmental policy and planning (economics, law, policy analysis, political science), and cultural studies (literature, geography, philosophy and development studies). These programs were typically initiated under the leadership of senior, tenured faculty members from many disciplines whose thinking began to coalesce around the holistic idea of human ecology (Schoenfeld 1979). Approximately 300 environmental programs were established during the first wave of proliferation from 1965-1975 (Maniates and Whissel 2000).[1] A 1978 (Schoenfeld and Disinger) study indicates that most programs established during this period were primarily based upon existing disciplinary areas; only four of the forty-five programs represented in the study were named environmental science(s) or environmental studies. A number of these early programs did not survive; a follow-up study of the forty-five programs initially surveyed in 1978 indicated that only two-thirds were still alive and well in 1987 (Disinger and Schoenfeld 1987).

The number of environmental programs leveled off at around 500 in 1980 and remained there until about 1990 (Maniates and Whissel 2000). Caldwell (1983) attributed this decline in growth to four factors: (1) reaction against "back-to-nature" environmentalists; (2) economic distress and concerns linked to the alleged cost of environmental controls; (3) resentment over environmental regulations; and (4) competition with social issues such as poverty, racism and war. These factors, along with decreasing public concern about pollution, resulted in declining support for environmental programs from university and college administrators, private foundations and the federal government. Many programs shifted away from a search for innovative holistic solutions to more applied emphases, including conservation, mitigation of environmental risks, pollution control, waste management, and regulatory compliance. The emphasis on the social contexts of environmental problems declined while the focus on science-based solutions increased due to public perceptions that science was a more objective, effective, or uncontroversial means for solving environmental problems (Disinger 1988, Cortese 1992, Strauss 1995).

A new wave of rapid environmental program proliferation began around 1990 (Manning 2000, Maniates and Whissel 2000, Romero and Jones 2003) and continues today. The renewed interest in environmental programs was tied to increasing awareness of the complex challenges posed by global environmental issues. The concept of sustainable development entered the public lexicon in 1987 when the World Commission on Environment and Development published *Our Common Future.* This report includes the most often-cited definition of sustainable development: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs," and prompted the United Nations to hold the first Conference for Environment and Development (Earth Summit) in 1992. The first international declaration on sustainability emerged from the Summit—the Rio Declaration on Environment and Development (Agenda 21).[2] Three additional major international declarations on sustainable development have been issued in the past decade: The Earth Charter released by the Earth Charter Commission in 2000,[3] the Johannesburg Declaration on Sustainable Development drafted during the 2002 World Summit on Sustainable Development,[4] and the United Nations declaration of 2005-2014 as the Decade of Education for Sustainable Development.

[1] The first environmental studies program may be the Center for Environmental Studies at Williams College, MA, established in 1967.

[2] http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=78&ArticleID=1163

[3] http://www.earthcharter.org/

[4] http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/POI_PD.htm

Higher education institutions occupy the forefront of the sustainability movement. The Talloires Declaration (University Presidents' Environmental Action Agreement) was drafted by a group of international university presidents and chancellors in 1990 and served as the first official statement made by university administrators of a commitment to sustainability in higher education.[5] Signed by more than 350 university presidents and chancellors from 40 countries, it presents a ten-point action plan for incorporating sustainability and environmental literacy in teaching, research, operations and outreach at colleges and universities. Item 3 of the plan states that higher educational institutions should: "Establish programs to produce expertise in environmental management, sustainable economic development, population, and related fields to ensure that all university graduates are environmentally literate and responsible citizens." A number of new organizations and journals have been established to promote these efforts, including the *Association for the Advancement of Sustainability in Higher Education* (over 750 member colleges and universities); the *American College & University Presidents' Climate Commitment* (over 650 signatories); *University Leaders for a Sustainable Future;* the *Disciplinary Associations Network for Sustainability;* the *Higher Education Associations' Sustainability Consortium; the U.S. Partnership for Education for Sustainable Development;* and the *International Journal of Sustainability in Higher Education*.

Many existing and newly-created environmental programs renewed their attention to the social, political, and ecological contexts of environmental issues combined with a new emphasis on complexity, systems understanding, and the relevance of temporal and spatial scales (Rest 2002). The evolution of the concept of sustainability, rapid growth of ecosystem and social system knowledge, expanding Internet technologies, and the emergence of new integrated, interdisciplinary research approaches are sustaining the momentum toward systems-oriented approaches to environmental issues (Soule and Press 1998, Romero 2003). The recognition of the importance of cultural, social, and political aspects of environmental problems in education and research has also increased dramatically (Bonnett 1999, Romero 2003, Ginsberg, Doyle and Cook 2004). Increasingly, sustainability has become a guiding paradigm for many environmental programs.

Given the variety of program names and the lack of a consensus on what qualifies as an environmental program, estimates on how many environmental programs exist in the United States vary. Romero and Silveri (2006) identified 1059 academic environmental programs at 605 institutions of higher education. They define environmental programs as those that use the word "environmental" in their title or those who identify themselves as environmental in nature in their advertisement material, and include professional programs in environmental law, environmental health, environmental education, and environmental engineering. The author identified 840 IE programs at 652 institutions offering 1183 degrees using different selection criteria (see Chapter IV).

Environmental programs have been variously grouped into categories using degree levels, program objectives and subject emphases.

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[5] http://www.ulsf.org/programs_talloires.html

- Schoenfeld (1979) identified three program categories based on degree level: (1) undergraduate programs that focus either on a liberal arts and sciences education to prepare students for responsible citizenship or technically oriented programs to prepare students for specific environmental careers, (2) master's programs that use multidisciplinary approaches to address various aspects of environmental management, and (3) doctoral programs grounded in the physical and life sciences that apply interdisciplinary approaches to societal problems. It is interesting to note that he correlates interdisciplinarity with degree level.
- Three subject-based models for graduate programs are described by Kim and Dixon (1993): (1) environmental design, policy and management (dominated by sociology and economics with emphases on politics, philosophy and architecture); (2) environmental health, biology, and resource science (dominated by ecology and biology with emphases on public health, medicine and agriculture); and (3) environmental engineering (dominated by mathematics and statistics with emphases on geology, physics and chemistry).
- Lemons (1994) groups programs into four types based on program objectives. The first type is designed to train students to investigate complex problems and devise solutions using an interdisciplinary and systems-thinking approach; to work effectively with diverse groups of people, institutions and organizations; to communicate effectively with disciplinary specialists; to develop leadership abilities; and to understand and appreciate differing epistemologies, values, and ethics. He believes this type of program serves as the "basis for contemporary higher education goals" and has been instrumental in educating students who go into the environmental field. He notes that the goals of such programs are increasingly interpreted in the contexts of sustainable development and environmental protection.

  The second type is designed to train environmental professionals and specialists, such as programs in environment engineering, health and law. This type emphasizes the acquisition of knowledge and skills required for specific professions combined with an awareness of environmental issues, the consequences of human actions, values and ethics, and the socio-political aspects of environmental problems and solutions.

  The third type addresses particular environmental issues or resource problems. Students obtain expertise in particular dimensions of specific environmental issues or problems by utilizing unique sets of knowledge and skills drawn from diverse disciplinary areas.

  Lemons' fourth type is action-oriented, designed for graduates who wish to work in organizations and communities to bring about social change. This type is based on the view that alteration of society's values and behaviors are required to solve environmental problems; thus enhancement of environment literacy, advocacy of environmentally responsible action, and facilitation of social change is included in these programs' curricula.

Ultimately, Individual programs reflect the characters and strengths of their host institutions and the influence of a variety of factors, including faculty areas of expertise and interests, program philosophies, decisions on balancing breadth and depth, level of commitment to professional and specialized training, administrative location, and institutional support (Disinger and Schoenfeld 1987; Weis 1990; Fletcher 1992; Lemons 1994; O'Reily, Deegan and Columbo 1996; Manning 1999; Romero and Jones 2003).

Environmental Careers Evolution

The evolving environmental movement has a powerful influence on environmental careers and education programs through its effects on the sociopolitical and economic milieus of the United States. Sherburne Abbott, the Associate Director of Environment Office of Science and Technology Policy in the Obama Administration, identified five waves of the environmental movement in the United States (referenced in Ginsberg, Doyle and Cook, 2004:5-9): (1) the preservation movement during 1850–1890, (2) the management movement during 1890–1950, (3) the ecological movement during 1950–1970, (4) the regulatory movement during 1970–1990, and (5) the sustainability movement from 1990 to the present.

- The preservation movement was inspired by a romantic notion of wild nature. As wilderness disappeared, proponents pushed to set aside natural wonders and protect them from development. This era saw the designation of the first national park at Yellowstone in 1872 with others soon following. The Sierra Club was formed and Congress set aside lands that would later come under the management of the U. S. Fish and Wildlife Service.
- The management movement was born from the concern for long-term, prudent use of natural resources such as water, forests, agricultural land, and wildlife habitat. This era saw the increasing expansion of federal government actions to set aside and manage federal lands, which led to the creation of new environmental careers for natural resource scientists and management experts and the institutionalization of academic programs to train these professionals. Congress authorized the creation of the U. S. Forest Service and the Bureau of Land Management, provided significant new resources for government agencies such as the U. S. Geological Service, and established the Civilian Conservation Corps that worked to expand a growing environmental infrastructure.
- Advancements in scientific and ecological understanding marked the emergence of the ecological movement. This era was marked by a growing concern about the ways human activities were causing ecological damage, negatively impacting human health, and compromising the quality of life for Americans. Various events galvanized public anxiety, including the Cuyahoga River Fire, the Great London Smog, and the publication in 1962 of Rachel Carson's landmark book, *Silent Spring*, which warned of the dangers of pesticides. Several pieces of federal environmental legislation were enacted such as the first Clean Air Act, the Wilderness Act, the Water Quality Act, and the Solid Waste Disposal Act.
- The regulatory movement stimulated an explosion of environmental legislation aimed at pollution control and to a lesser extent pollution prevention. The U. S. Environmental Protection Agency was established in 1970 and the most far-reaching environmental legislation ever enacted, the National Environmental Policy Act, was signed into law. This

legislation required "environmental impact statements" for all federal actions and was widely copied at the state level. A host of other environmental acts followed, including the Clean Water Act; Endangered Species Act; Toxic Substances Control Act; Safe Drinking Water Act; Marine Protection, Research and Sanctuaries Act; Coastal Zone Management Act; National Forest Management Act; Resource Conservation and Recovery Act; Comprehensive Environmental Response, Compensation and Liability (Superfund) Act; and Federal Lands Policy and Management Act. The passage of these bills generated a burgeoning job market for environmental professionals in both existing and newly defined areas of expertise.

- The sustainability movement began following the publication in 1987 of the United Nations World Commission on Environment and Development report *Our Common Future* which brought the concept of sustainability into public discourse. The sustainability movement is characterized by a new approach to solving complex environmental problems through solutions that integrate ecological heath, social justice and economic security over varying temporal and spatial scales. Moving toward sustainability has become a priority goal for many diverse institutions. As a result, entrepreneurship, research and development, career opportunities and investment in sustainability and "green" ventures are all experiencing phenomenal growth in the United States and worldwide. Higher education institutions are also rapidly adopting sustainability as a goal across the campus in governance, investment, education, research, extension activities, and operations.

Each of the four waves preceding the current sustainability wave produced laws, regulations, technical and scientific approaches, professions, and institutions appropriate to the missions and goals of the time. Each subsequent wave was built upon the foundations that preceded it while adding new approaches, objectives and career paths. The result is an "awkwardly constructed world of environmental employers and professions, taking approaches that as often as likely to conflict as they are to reinforce each other" (Ginsberg, Doyle and Cook 2004:8).

The emergence, growth, and decline of various environmental careers also follow cycles driven by policy and technological changes. Political demands that manifest during environmental movements influence government policies which in turn drive new investment, research and development, environmental career creation, expansion, and decline. Kevin Doyle, the president of Green Economy, a Boston-based training, research and consulting firm, researches and writes frequently about environmental jobs in the United States. He formerly served as the National Program Director for the Environmental Careers Organization. Doyle describes three factors that have influenced the evolution of careers from the 1970s to the present (Doyle 2005). The first is industry maturation. As environmental industry sectors respond to changing market demands, specific career sectors explode, mature, consolidate, and decline. Some professions that were established during the 1970s matured and are now stagnant or declining, while emerging sectors such as alternative energy, green building, ecotourism, and green business are experiencing expansion.

Doyle's second factor is technology cycles. Technology increases the need for some types of environmental professionals and decreases the need for others. Field monitoring, hazardous materials management, and GIS mapping are examples of areas where the need for specialists has declined with technological improvements.

The third factor is the declining power of the federal government as an employment driver. Although the federal government remains the largest single employer of environmental professionals, two trends are emerging. Under political pressure to shrink the size of the federal workforce, many programs are being devolved to state and local governments and jobs are being outsourced to private contractors. According to Ginsberg, Doyle and Cook (2004), environmental industries and other business sectors were the largest U.S. employers of environmental program graduates in 2004, accounting for approximately 43% of all new environmental hires, followed by governments (federal, state and local) with 42% and academic and nonprofit organizations with 15%. According to the U. S. Bureau of Labor Statistics (2008) the largest employer for occupations in the category environmental scientists and specialists is governments—43% are employed by governments (8% federal, 35% local/state), 38% by private industries and businesses, and 19% by the non-profit and academic sectors.

A recent analysis of the environmental labor market in the European Union similarly describes an environmental employment lifecycle tied to environmental policy changes and subsequent demands for new technologies and services (Krozer 2005). The study, based on 16 reports of the European Union's ESSENCE network,[6] found that the demand for environmental professionals described as either "specialists" or "generalists" fluctuated following changes in government policies and investments in environmental technology. Demand for specialists (technologists and engineers) rises immediately following the implementation of new government policies which drives spending on new technologies, which is then followed by a shift to demand for more generalists (managers and administrators). The market becomes saturated after a period of time, until new political demands or technological innovations stimulate the development of new policies or technologies which again drive an increase in demand for new types of specialists and generalists.

Surveys of Employers and Environmental Practitioners

Although the number of graduates from IE programs has increased and the demand for environmental jobs is growing, few studies have examined whether the education and preparation that graduates receive prepare them for successful environmental careers. The limited number of studies to date (most from outside the U. S.) indicates that employers are emphasizing skills; seeking graduates with communication, analytical, problem solving, and managerial skills as well as a broad understanding of environmental issues and decision-making contexts.

John Esson, Director of the Green Careers Center, reports that national environmental employment surveys conducted by his firm from 2000-2005 indicate the two most important

[6] The ESSENCE network (Environmental Sciences Strengthened in Europe by Education, Networking and Conferences) carried out a number of projects and activities during 1998-2003, including collecting data on employer demand for environmental expertise in 19 EU countries. See A. Jamison, 2003/2004. Memories of ESSENCE: Reflections on Environmental Higher Education in Europe, *Environmental Sciences* 1(3):238-253 for more information.

characteristics in employee candidates are written and verbal communication skills and a willingness to take responsibility (Esson 2005). Other desirable skills are the ability to work effectively as part of a team and the technical expertise and knowledge related to specific jobs. Thomas (1992) found employers in Australia particularly value graduates who can function as "environmental integrators" by (1) managing or coordinating groups of people or projects, (2) participating in multidisciplinary teams, and (3) integrating people and information (effective networking). Another survey of employers in Australia by Thomas and Nicita (2003) found that employers emphasize workplace experience (internships), adaptability, and flexibility. Attributes of particular concern to employers are awareness of environmental issues and their social aspects as well as understanding political and business processes.

A survey of employers of graduates of master's and doctoral level environmental programs reveal that employees are expected to take leadership roles in influencing environmental management and policy (Giacomelli, Travisi and Nava 2003). Employer preferences indicate a shift away from detailed technical abilities to broader analytical and problem-solving skills in management, financial analysis, communications, and teamwork. They found that graduates of environmental science graduate programs in Italy obtained jobs that require managerial skills, skills in interacting with experts from different disciplines to find operative (defined as practical, measurable, policy relevant) solutions, and a broad educational background that embraces the socioeconomic disciplines as opposed to expertise in performing specific technical tasks. "The environmental labor sector is seeking [graduates] with a broad educational basis who also embrace the socioeconomic disciplines, as opposed to a highly specialized person whose skills can already be found in other more traditional scientific disciplines" (Giacomelli, Travisi and Nava 2003, 14).

Environmental professionals also stress an emphasis on skills. A recent study of 600 respondents working in environmental professions in Australia found that a high level of competency in general skills (including written and oral communication, critical thinking/judgment, leadership, planning/organizing projects, teamwork, and facilitation) and practical work experience were cited most often as requirements for success (Thomas et al. 2007). A recent article on the transition from student to employee argues that knowledge of basic science, ecosystem interactions and policy are all important for professional success, but organizational abilities and creative problem-solving skills are essential (Hull 2009). Similarly, an environmental practitioner with over 25 years of experience identified four key skills essential for environmental professionals—communication, collaboration, team learning and stewardship (defined as the willingness to be accountable for the larger whole) (Deverman 2006).

Environmental professionals also point to the relevance of sustainability-oriented integrative processes in their work, particularly the need for professional skills related to context-specific problem solving that engages a variety of public and private entities (Jørgensen and Lauridsen 2005; Martin, Brannigan and Hall 2005; Newman 2005; Runhaar, Driessen and Vermeulen 2005). They emphasize that professional competence is linked to problem solving in specific contexts—"working with environmental issues in the interplay of companies, consultants, regulatory authorities, local communities and non-governmental organizations" (Jørgensen and Lauridsen 2005, 49). They conclude that environmental professionals' education should be structured "more along thematic guidelines that provide students with a set of problem-solving strategies, and integrate general management principles and organizational theory" (Jørgensen and Lauridsen 2005, 49).

A recent analysis by Brand and Karvonen (2007, 21) argues that an "ecosystem of expertise" is needed to effectively develop, implement, and manage sustainability projects. This expertise should include: (1) an "outreach expert who communicates effectively to non-experts," (2) an "interdisciplinary expert who understands the overlaps of neighboring disciplines," (3) a "meta-expert who brokers the multiple claims of relevance between different forms of expertise," and (4) a "civic expert who engages in democratic discourse with experts and non-experts."

Moving toward sustainability/sustainable development is recognized worldwide as a primary goal for the twenty-first century (Lubchenco 1998; Kates et al. 2001; Kates, Parris and Leiserowitz 2005). In response to the need to develop sustainability related skills, several new professional organizations have been created to foster professional development in sustainability. These include the International Society of Sustainability Professionals based in the U. S. (www.sustainabilityprofessionals.org), the Professional Practice for Sustainable Development group (PP4SD; www.pp4sd.org.uk) based in the United Kingdom, the Association for Sustainability Practitioners (www.asp-online.org) also based in the United Kingdom, and the Sustainability Practitioners Association based in Australia (www.spa.asn.au).

Importance of Subject Areas for Interdisciplinary Environmental Programs

Only a few authors have addressed core competencies for higher education environmental programs. The most prominent is the expert-defined benchmark recommendations for honors graduates of undergraduate environmental degree programs developed in the United Kingdom (Eastwood and Blumhof 2002). The U.K. benchmark recommendations include key skills as well as subject-specific and generic knowledge for undergraduate programs in earth science, environmental science, and environmental studies (Quality Assurance Agency for Higher Education 2000). Sherren (2007) surveyed a small group of environmental experts to identify disciplinary content recommended for undergraduate programs in sustainability. The suggested content includes ecology, economics, applied ethics, environmental sciences, cultural studies, policy and political science, resource management, and international relations or development studies. In addition to these two reports, Kim (2003) describes a set of evaluation criteria primarily targeted for K-12 environment education programs adapted from Gardella's Environmental Education Curriculum Inventory (1993).

A number of authors have argued for the importance of specific content or subject areas in environmental program curricula. Several contend that an explicit foundation in comparative epistemology and values-awareness is crucial for training students to think critically within and across the various disciplines (Jones, Merritt and Palmer 1999; Andersen, Worthen and Polkinghorn 2001). Others emphasize the importance of history in gaining an understanding of the forces shaping the modern world (Opie 1987) or the importance of philosophical inquiry into the role of values (Chapman 2007).

Foster (1999, 358) contends that both the social sciences and humanities are essential to framing environmental problems and implementing solutions to environmental problems. He argues that the conventional view of IE higher education privileges a positivistic approach. "The received understanding of interdisciplinarity in environmental higher education depends on construction of the environmental agenda which tacitly privilege positivistic assumptions associated with the physical and biological sciences. If, however, we take seriously the heuristic force of the key humanities disciplines in regard to our environmental situation, precisely this privileging will be an issue." He quotes Grove-White, "…environmental issues are more than simply physical. They are also inescapably philosophical, ethical, political and cultural. The particular 'objective' environmental problems and issues which society recognizes as any one moment are shaped and determined by processes of human judgment and social negotiation, even in their very definitions…" (Grove-White 1997, 109). McKeown-Ice and Dendinger (2000) agree that science alone will not solve environmental problems and that the social sciences are important for understanding stakeholders' differing opinions on defining problems, analyzing problems, and devising appropriate solutions to problems.

Thomas and Nicita (2003) note that solving environmental problems and achieving sustainable solutions requires operative (practical, measurable, policy relevant) solutions and that information about environmental dynamics and the relative sustainability of activities are strategic tools for business and industry.

An awareness and understanding of the capacities of engineering is viewed as providing a necessary understanding of the practical problems and limits of technical solutions and the role engineering plays in constructing environmentally sustainable built environments (Dominik, Loizeau and Thomas 2003; Brakewood, Cooper and Flora 2003).

Kevin Doyle, the president of Green Economy and former National Program Director of the Environmental Careers Organization, argues that a successful environmental education program should emphasize the acquisition of skills including communication, project management, teamwork, information technology, analytical thinking, and interpersonal skills (Doyle 2005). His book on environmental careers, the *ECO Guide to Careers that Make a Difference: Environmental Work for a Sustainable World,* lists the top ten skills for 21st century environmental professionals as: (1) communication ability (speaking, writing, visual, listening), (2) collaboration ability, (3) creativity and innovation, (4) broad environmental science understanding, (5) analytical and critical thinking/problem-solving ability, (6) a positive attitude/willingness to work hard, (7) information technology skills, including geographic information systems, (8) leadership ability, (9) occupation-specific skills, and (10) a "customer" orientation focused on the needs of stakeholders (Ginsberg, Doyle and Cook 2004, 47)

CHAPTER III

RESEARCH DESIGN AND SAMPLE CHARACTERISTICS

Research Design

A comprehensive literature review revealed few previous studies that address the question of IE program identity and/or core competency criteria. Given the lack of evidence based inquiry into this topic or equivalent studies for comparison this study is exploratory in nature.

The study addresses four broad research questions designed to inform and facilitate discussion on field identity and core competency criteria:

1. What are the perspectives among IE program leaders regarding curriculum design? What do they have in common and how do they differ?
2. What dimensions underlie the inclusion of various knowledge and skill areas in IE program curricula? How are these areas related and how may they be combined into interdisciplinary core competency areas?
3. What types of ideal curriculum models of IE program curricula exist? What are the characteristics of each model?
4. How are administrative and degree program attributes related to ideal curriculum types? What do these relationships indicate concerning program structure and evolution?

A combination of social sciences qualitative and quantitative statistical methods were used to answer these questions including: qualitative emergent theme analysis, online surveys, Q methodology, multiple regression, maximum likelihood factor analysis, principal components analysis, SPSS two-step cluster analysis, Ward's cluster analysis, discriminant analysis, analysis of variance (ANOVA) and Kruskal Wallis analysis of variance by ranks (KWANOVA).

Both the qualitative and quantitative methods require the researcher to make decisions about various parameters of the statistical analyses. An abductive reasoning approach is an appropriate way for a researcher to make these decisions and was used extensively in this research. Abduction is a method of logical inference introduced by the philosopher Charles

Sanders Peirce. He argued that in addition to deductive inference (necessary inference or testing existing theory with observations) and inductive inference (probable inference or developing theory from observations), there is a third type of probable inference: abductive inference (educated inference or conjecture), which is the process by which new knowledge is generated. According to Peirce, these three forms of reasoning—deduction, induction, and abduction—together form an integrated scientific methodology. The scientific method is a process that begins with abduction, an educated conjecture or hypothesis; followed by deduction, the process of inferring from the hypothesis and finally, induction; which comprises the entire process of hypothesis testing, rather than only inferring from a sample to a population (Stanford Encyclopedia of Philosophy 2006).

In practice, Peirce's triadic logic may be described as an iterative process between analysis and synthesis where observations are interpreted within a contextual frame (Barton and Haslett 2007). According to Peirce the development of a hypothesis is not a purely intuitive process, but is instead a form of educated inquiry. Abduction involves a learning process cycle of inquiry that starts with observing 'surprising facts' which leads to the formation of an explanatory hypothesis, followed by analysis and actions that generate new 'surprising facts.' This iterative method of examining the results of statistical analyses and interpreting the findings is utilized in Q methodology, factor analysis, and cluster analysis as well as in interpretation of the significant correlations found using tests one-way analysis of variance (ANOVA) and Kruskal Wallis one way analysis of variance by ranks (KWANOVA) tests. The veracity of the interpretation of the findings is supported by recommended measures of validity for each test, feedback from presentations at various international and national conferences, and by the convergence of findings obtained through different methodological approaches.

The study was conducted in two phases: an initial online survey and Q methodology analysis with a sample comprised of 61 CEDD members, and a nationwide survey and data analysis with a sample of 260 respondents representing IE programs awarding 343 degrees.

An overview of the research design and characteristics of the samples for each phase are discussed below. Details on the methodology used to answer each of the four research questions are included in the following chapters. Chapter IV provides an overview of IE programs in the U. S. obtained from the census information gathering in preparation for the national survey and selected survey results.[7] Chapters V through VIII present the methods used to address each of the four research questions and the results. Finally, Chapter XI discusses implications for building workforce capacity for the 21st century, conclusions, limitations of the study and next steps.

[7] For a complete report of the results for each question included in the national survey see Vincent, Shirley. 2010. *Results of the CEDD National Study of U. S. Interdisciplinary Environmental Programs: a report of the Curriculum Committee of the Council of Environmental Deans and Directors.* National Council for Science and the Environment, Washington, DC.

Phase I – Q Methodological Analysis

In the first phase of the curriculum study, we sought to answer the first research question about the number of perspectives on environmental program curriculum design that program administrators hold, how these perspectives differ, and what they have in common. Q methodology is a technique for systematically revealing subjects' perspectives and has been widely used as a research tool for empirically determining the perspectives of participants in a variety of processes. It can be used to identify various viewpoints and perceptions about a particular situation, provide insight into the attributes of each perspective, explicitly outline areas of consensus and conflict, and assist in developing a common view. We used this method to discern the various perspectives regarding environmental program curriculum design held by the administrators of IE programs at institutions affiliated with the National Council for Science and the Environment (NCSE) that participate in the Council of Environmental Deans and Directors (CEDD).

The Q methodology study was conducted in two steps: (1) an online survey to obtain opinions on curricular design and program characteristics, and (2) an online Q sorting exercise to ascertain perspectives on curricular design and to access conflicts and characterize the nature of debate.

Sample Profile, Size and Representativeness. This phase of the study was conducted in 2003 with volunteer participants from the CEDD membership who identified themselves as administrators of IE programs (see Appendix A for the list of participating institutions, Appendix B for the survey questionnaire and Appendix J for the Institutional Review Board approval). Respondents included 61 CEDD members representing IE programs at 57 institutions of higher education. A subset of the respondents—44 CEDD members representing 42 institutions—participated in the Q sorting exercise.

The representativeness of the sample was compared using proportions for the Q survey sample data and the census IE program data collected in preparation for the national survey at α=.05 (two tailed test). Four parameters were tested: institution control (public or private-not-for-profit), institution basic Carnegie class, institution U. S. census division, and program degree type (name/level). The sample was found to be representative for all four parameters. Only five significant differences were noted: two in institution Carnegie class and three in program degree types. No significant differences were noted in proportions for institutional control or census divisions (Tables 1 and 3).

Research Universities (very high research activity) institutions are over-represented in the survey and *Master's Colleges and Universities (larger programs)* institutions are underrepresented, but there were no significant differences in proportions for all other basic Carnegie classes (Table 2). Environmental science(s) degrees were underrepresented at the baccalaureate level and environmental studies degrees and degrees with other names were overrepresented at the doctoral degree level (Table 4). The census count of programs reveals that research intensive doctoral universities are more likely than other institution types to host IE programs, which likely explains the reason for their overrepresentation.

Table 1. Q survey sample representativeness: institution control

Institution control	Census proportion (*n*=652)	Sample proportion (*n*=57)
Public	44.2%	52.6%
Private not-for profit	55.8%	47.4%

Table 2. Q survey sample representativeness: institution basic Carnegie class

Basic Carnegie class	Census proportion (*n*=652)	Sample proportion (*n*=57)
Doctoral/Research Universities – Very High Research Activity	13.3%	*31.6%
Doctoral/Research Universities – High Research Activity	10.9%	17.5%
Doctoral/Research Universities	5.4%	10.5%
Master's Colleges and Universities – Large	22.4%	**8.9%
Master's Colleges and Universities – Medium	9.0%	3.5%
Master's Colleges and Universities – Small	5.4%	1.8%
Baccalaureate Colleges – Arts & Sciences	21.5%	21.1%
Baccalaureate Colleges – Diverse Fields	10.0%	5.3%
Other	1.7%	0%

*Significantly overrepresented; **significantly underrepresented; α=.05 (two-tailed test)

Table 3. Q survey sample representativeness: institution location

U.S. census division	Census proportion (*n*=652)	Sample proportion (*n*=57)
New England	11.7%	14.3%
Middle Atlantic	18.7%	14.3%
East North Central	14.9%	10.7%
West North Central	8.1%	3.6%
South Atlantic	16.3%	26.8%
East South Central	4.1%	3.6%
West South Central	7.5%	12.5%
Mountain	5.8%	1.8%
Pacific	11.8%	12.5%

Table 4. Q survey sample representativeness: degree type (name/level)

Degree name/level	Census proportion (*n*=1183)	Sample proportion (*n*=86)
Baccalaureate environmental science(s)	31.5%	**17.4%
Baccalaureate environmental studies	21.6%	19.8%
Baccalaureate other name	14.9%	9.3%
Masters environmental science	8.8%	11.6%
Masters environmental studies	2.5%	5.8%
Masters other name	10.9%	15.1%
Doctoral environmental science(s)	4.5%	7.0%
Doctoral environmental studies	0.5%	*3.5%
Doctoral other name	4.8%	*10.5%

*Significantly overrepresented ; **significantly underrepresented; α=.05 (two-tailed test)

Phase II – National Survey and Data Analysis

The second phase of the curriculum study was designed to answer the remaining three research questions: (1) the identity of the dimensions that underlie the inclusion of knowledge and skill areas in interdisciplinary program curricula, and how these dimensions are related to form potential interdisciplinary core competency areas; (2) the number and characteristics of ideal curricular models for IE education; and (3) how administrative and degree program attributes may be related to the ideal curriculum types and what these relationships indicate concerning program structure and evolution.

This phase of the study was conducted in three steps: (1) identification of all U. S. programs awarding baccalaureate and graduate level IE degrees, (2) an online survey to obtain IE program administrators' views on program structure and curriculum design, and (3) data analyses appropriate for each of the three research questions.

Several statistical methods were used to analyze the data gathered by the survey. First, descriptive statistics appropriate to each question were calculated and responses to the open-ended questions coded according to emergent themes. Second, exploratory factor analysis (maximum likelihood method) was used to determine the factors (dimensions) underlying the importance ratings of 16 knowledge areas and 23 skills in ideal program curricula. Third, principal component analysis followed by SPSS two-step method clustering was used to reveal groups of administrators who prefer similar ideal curricular models. Fourth, discriminant analysis was used to confirm the cluster solution and aid in interpretation of the results. Finally, two types of analysis of variance tests were used to explore relationships among ideal curriculum types, knowledge and skill factors, and other program and degree program features: one-way analysis of variance (ANOVA) for scale variable data and Kruskal-Wallis one-way analysis of variance by ranks (KWANOVA) for ordinal and categorical variable data. Kruskal-Wallis is a non-parametric test of the difference in the shape or location (central tendency) of the populations underlying two or more groups. The significance level was set at $\alpha=.05$ for all analyses.

Sample Profile, Size and Representativeness. A comprehensive online survey of United States IE program administrators was conducted during January-May 2008 (see Appendix A for the list of participating institutions, Appendix F for more information on the survey design, Appendix G for the survey questionnaire and Appendix J for the Institutional Review Board approval). The survey was aimed at program administrators not only because they have detailed knowledge of their IE degree programs but also because less than half of IE programs have their own core faculty.

For the national survey IE programs were defined as degree-granting programs at the baccalaureate and graduate levels that focus on the human-natural systems interface from a broad interdisciplinary perspective. These criteria include all degree programs in the United States named environmental science(s) or environmental studies as well as degree programs with related names such as sustainability, environmental policy, environmental management and natural resources management.

Programs not included were those that offer only associate degrees, minors/certificates, and professional degrees in allied fields such as environmental engineering, environmental law, environmental health and safety, environmental chemistry/toxicology, environmental geology/hydrology, conservation biology, sustainable agriculture, forestry/rangeland management, environmental economics, natural resource geography, and environmental statistics.

Several sources were used to identify institutions hosting programs that met the survey population criteria. An initial list was generated from a search of the U. S. Department of Education Integrated Postsecondary Data System (IPEDS at http://nces.ed.gov/ipeds/) to identify institutions that granted at least one degree in selected Classification of Instructional Programs (CIP) areas during 2002-2006. The program areas selected from the CIP schema developed by the National Center for Education Statistics were:

- 03.0103 Environmental Studies (new in 2003)

  Description: A program that focuses on environment-related issues using scientific, social scientific, or humanistic approaches or a combination. Includes instruction in the basic principles of ecology and environmental science and related subjects such as policy, politics, law, economics, social aspects, planning, pollution control, natural resources, and the interactions of human beings and nature.

- 03.0104 Environmental Science (new in 2003)

  Description: A program that focuses on the application of biological, chemical, and physical principles to the study of the physical environment and the solution of environmental problems, including subjects such as abating or controlling environmental pollution and degradation; the interaction between human society and the natural environment; and natural resources management. Includes instruction in biology, chemistry, physics, geosciences, climatology, statistics, and mathematical modeling.

- 03.0102 Environmental Science/Studies (replaced in 2003)
- 03.0101 Natural Resources/Conservation, General

  Description: A general program that focuses on the studies and activities relating to the natural environment and its conservation, use, and improvement. Includes instruction in subjects such as climate, air, soil, water, land, fish and wildlife, and plant resources; in the basic principles of environmental science and natural resources management; and the recreational and economic uses of renewable and nonrenewable natural resources.

- 03.0201 Natural Resources Management and Policy

  A program that prepares individuals to plan, develop, manage, and evaluate programs to protect and regulate natural habitats and renewable natural resources. Includes instruction in the principles of wildlife and conservation biology, environmental science, animal population surveying, natural resource economics, management techniques for various habitats, applicable law and policy, administrative and communications skills, and public relations.

Additional sources were used to supplement the initial IPEDS-generated list because (1) the available CIP areas do not accurately reflect the content and/or the range of IE programs, (2) all 4-year institutions do not provide data to the IPEDS system (only those that participate in the federal financial assistance programs are required to participate), and (3) the accuracy of the data is unclear (the institutional representative assigned with completing the IPEDS survey may not understand how the CIP areas align with their institution's degree programs).

The five additional sources used were: (1) the Council of Environmental Deans and Directors membership list,[8] (2) the survey data from the online report "Not all are created equal: an analysis of the environmental programs/department in U.S. academic institutions from 1900 until May 2005,"[9] (3) institutions that participated in a American Association for the Advancement of Science (AAAS) sustainability program survey,[10] (4) programs at institutions listed in the Association for the Advancement of Sustainability in Higher Education's AASHE Digest 2006,[11] and (5) searches for environmental undergraduate and graduate programs listed in Peterson's guide.[12]

The selection of programs not named environmental science or environmental studies for inclusion or exclusion in the survey population required the subjective judgment of the researcher. Decisions were based upon an examination of the descriptive information and degree requirements provided on program websites and in course catalogs. Following review of institution and program websites, 856 programs at 657 institutions were identified as meeting the selection criteria.

A total of 16 programs and 5 institutions were subsequently removed from survey sample list because the respondent (program administrator) reported the relevant program was either discontinued or did not meet the survey selection criteria, reducing the sample to 840 programs at 652 institutions awarding 1183 degrees.

The survey population included all programs meeting the selection criteria (census sample instead of a random sample) due to the relatively low number of programs (840) and the desire to obtain an optimally comprehensive database of program information for ongoing study.

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[8] Council of Environmental Deans and Directors . 2007. http://www.ncseonline.org/CEDD/Members/.

[9] Romero, A. and P. Silveri. 2006. Not All Are Created Equal: An Analysis of the Environmental Programs/Departments in U.S. Academic Institutions from 1900 until May 2005. *Journal of Integrative Biology.* http://clt.astate.edu/electronicjournal/Articles.htm.

[10] Banas, S. 2007. A Survey of University-Based Sustainability Science Programs. American Association for the Advancement of Science. http://www.aaas.org/programs/centers/sd/.

[11] Hummel, S., J. Dautremont-Smith, and J. Walton. 2007. AASHE Digest 2006: A Review of Campus Sustainability News. Association for the Advancement of Sustainability in Higher Education. http://www.aashe.org/resources/pdf/AASHEdigest2006.pdf.

[12] Petersons Guide. 2007. http://www.petersons.com/.

From the 840 program administrators asked to participate, we received completed survey responses from 260—a response rate of 31%. Specifically, we received responses that addressed 260 administrative programs at 238 institutions and 343 degrees. This sample was sufficient to measure correlations between attributes with a power of 0.90 to detect a 0.20 effect size at α=0.05. Results based on the full sample of respondents have a sampling margin of error of ±5% (α=0.05).

The representativeness of the national survey sample was compared using proportions for the sample data and the census program data collected for the target population at α=.05 (two-tailed test). The sample was found to be representative for all four parameters. Only four significant differences were noted: one in institution basic Carnegie class and three in degree type (name/level). No significant differences were noted in proportions for institutional control or census regions (Tables 5 and 7).

As in the phase I sample, *Research Universities (very high research activity)* institutions are overrepresented in the survey, but there were no significant differences in proportions for all other basic Carnegie classes (Table 6). Environmental science(s) degrees were underrepresented at the both the master's and doctoral levels and environmental studies degrees were overrepresented at the master's degree level (Table 8). Similar to the phase I survey sample, research intensive doctoral institutions are likely overrepresented because these institutions are more likely to host IE programs, and those offering graduate level degrees in environmental studies and other interdisciplinary areas appear to have more interest in the study.

Table 5. National survey sample representativeness: institution control

Institution control	Census proportion (*n*=652)	Sample proportion (*n*=260)
Public	44.2%	50.2%
Private not-for profit	55.8%	49.8%

Table 6. National survey sample representativeness: institution basic Carnegie class

Basic Carnegie class	Census proportion (*n*=652)	Sample proportion (*n*=260)
Doctoral/Research Universities – Very High Research Activity	13.3%	*19.6%
Doctoral/Research Universities – High Research Activity	10.9%	13.5%
Doctoral Universities	5.4%	5.4%
Master's Colleges and Universities – Large	22.4%	19.2%
Master's Colleges and Universities – Medium	9.0%	7.7%
Master's Colleges and Universities – Small	5.4%	6.2%
Baccalaureate Colleges – Arts & Sciences	21.5%	18.8%
Baccalaureate Colleges – Diverse Fields	10.0%	8.1%
Other	1.7%	1.5%

*Significantly overrepresented; α=.05 (two-tailed test)

Table 7. National survey sample representativeness: institution location

U.S. census division	Census proportion (*n*=652)	Sample proportion (*n*=260)
New England	11.7%	14.6%
Middle Atlantic	18.7%	20.8%
East North Central	14.9%	14.2%
West North Central	8.1%	7.3%
South Atlantic	16.3%	14.6%
East South Central	4.1%	2.7%
West South Central	7.5%	8.1%
Mountain	5.8%	6.2%
Pacific	11.8%	11.2%

Table 8. National survey sample representativeness: degree type (name/level)

Degree name/level	Census proportion (*n*=1183)	Sample proportion (*n*=343)
Baccalaureate environmental science(s)	11.7%	30.6%
Baccalaureate environmental studies	18.7%	25.6%
Baccalaureate other name	14.9%	16.0%
Masters environmental science	8.1%	**4.7%
Masters environmental studies	16.3%	*4.4%
Masters other name	4.1%	10.5%
Doctoral environmental science(s)	7.5%	**2.3%
Doctoral environmental studies	5.8%	0.9%
Doctoral other name	11.8%	4.1%

*Significantly overrepresented ; **significantly underrepresented; α=.05 (two-tailed test)

CHAPTER IV

UNITED STATES INTERDISCPLINARY ENVIRONMENTAL PROGRAMS OVERVIEW

U. S. Interdisciplinary Environmental Programs

This chapter provides an overview of IE programs in the United States and evidence of their rapid growth. The information presented is from the data collected during the census count of programs conducted in preparation for the national survey and selected data from the survey. The census count of IE degree programs conducted in 2007 indentified 652 U.S. institutions (1 in Guam, 6 in Puerto Rico), with 840 programs offering 1183 IE degrees.

The census indicates 40% of four-year colleges and universities in the United States offer IE degrees at the baccalaureate and/or graduate level. Figure 1 illustrates the percentage of institutions offering IE programs by state and Table 9 the number of institutions within each state. The percentage varies from a low of 7% percent (MS) to a high of 100% (AK, WY), and from a single institution (MS, WY) to sixty institutions (NY).

Figure 1. Proportion of U. S. four-year institutions hosting IE programs by state.

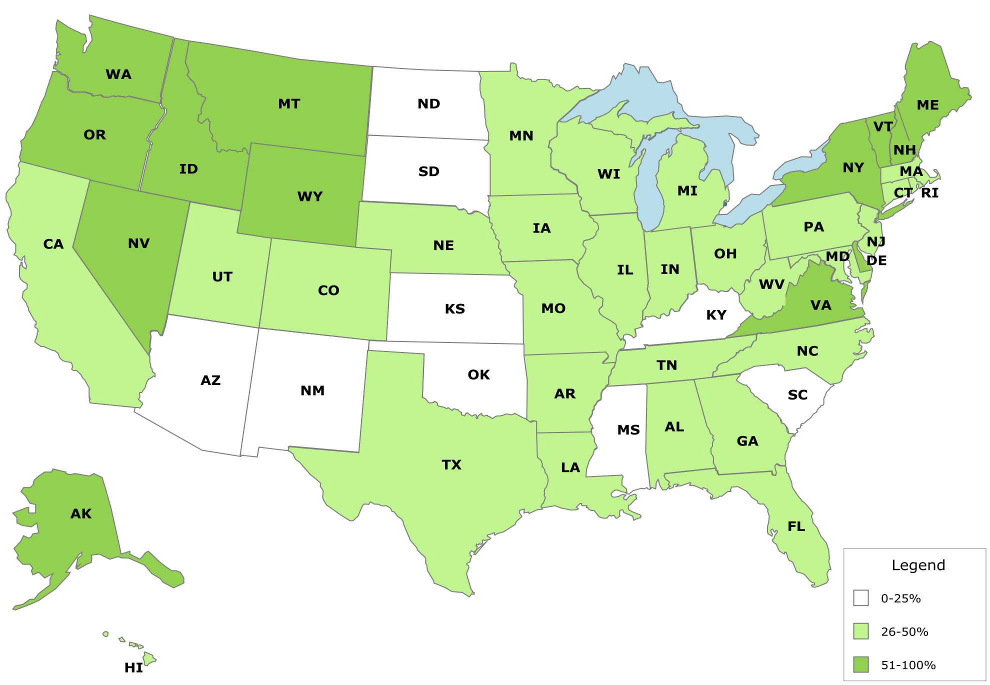
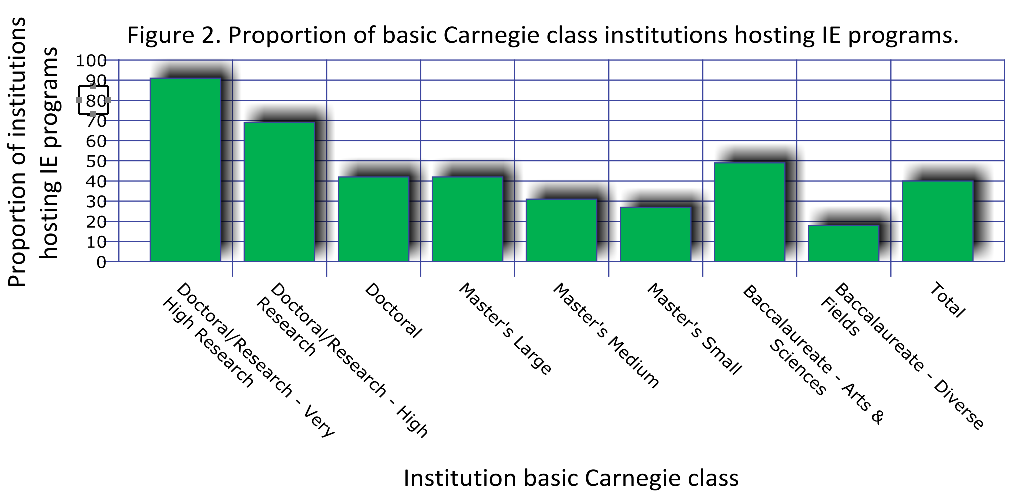


Table 9. Institutions hosting IE degree-granting programs

State or Territory	Institutions	Proportion of 4-year colleges & universities	State or Territory	Institutions	Proportion of 4-year colleges & universities
Alaska	5	100%	Montana	7	70%
Alabama	9	32%	North Carolina	22	44%
Arkansas	7	37%	North Dakota	2	20%
Arizona	4	24%	Nebraska	6	33%
California	41	39%	New Hampshire	9	53%
Colorado	11	44%	New Jersey	11	39%
Connecticut	9	43%	New Mexico	2	14%
District of Columbia	4	36%	Nevada	3	60%
Delaware	3	60%	New York	60	52%
Florida	19	38%	Ohio	27	44%
Georgia	11	26%	Oklahoma	5	24%
Guam	1	100%	Oregon	12	55%
Hawaii	3	38%	Pennsylvania	53	48%
Iowa	13	45%	Puerto Rico	6	17%
Idaho	4	57%	Rhode Island	3	38%
Illinois	25	46%	South Carolina	7	23%
Indiana	16	37%	South Dakota	2	15%
Kansas	6	23%	Tennessee	11	30%
Kentucky	5	19%	Texas	34	47%
Louisiana	7	33%	Utah	4	44%
Massachusetts	26	46%	Virginia	23	52%
Maryland	11	44%	Vermont	11	61%
Maine	13	81%	Washington	14	58%
Michigan	16	39%	Wisconsin	14	42%
Minnesota	15	41%	West Virginia	7	39%
Missouri	11	28%	Wyoming	1	100%
Mississippi	1	7%			

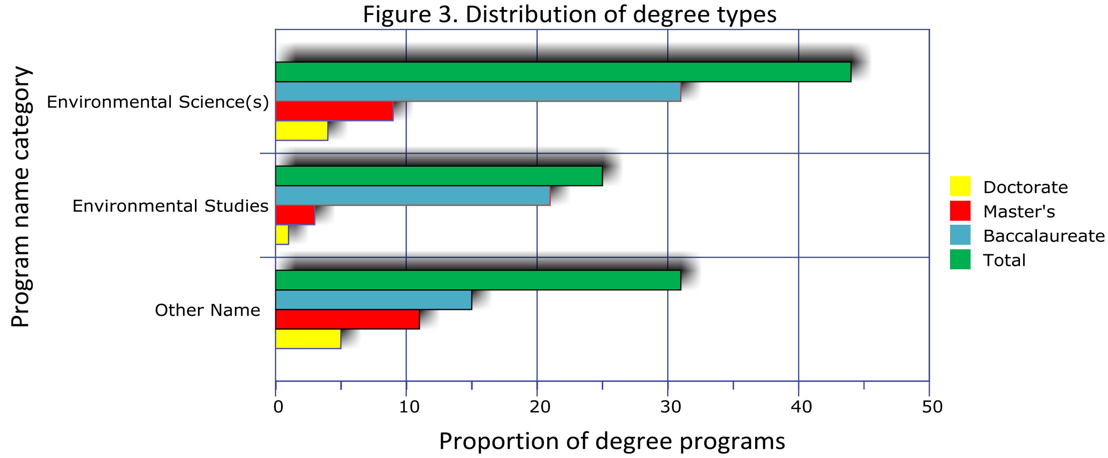
The proportion of institutions hosting IE programs varies by basic Carnegie classification and ranges from 91% of research universities with very high research activity to 18% of baccalaureate-diverse field institutions (Figure 2).

Figure 2. Proportion of basic Carnegie class institutions hosting IE programs.



Degree programs labeled environmental science(s) are the most prevalent, comprising 44% of all broadly IE programs. Another 25% are labeled environmental studies. Environmental studies degrees are awarded primarily at the baccalaureate level; only 11% of master's degrees and 5% of doctoral degrees are named environmental studies. The remaining 31% of program labels and focus areas vary widely, with programs focused on environmental policy, planning and management most common (Figure 3).

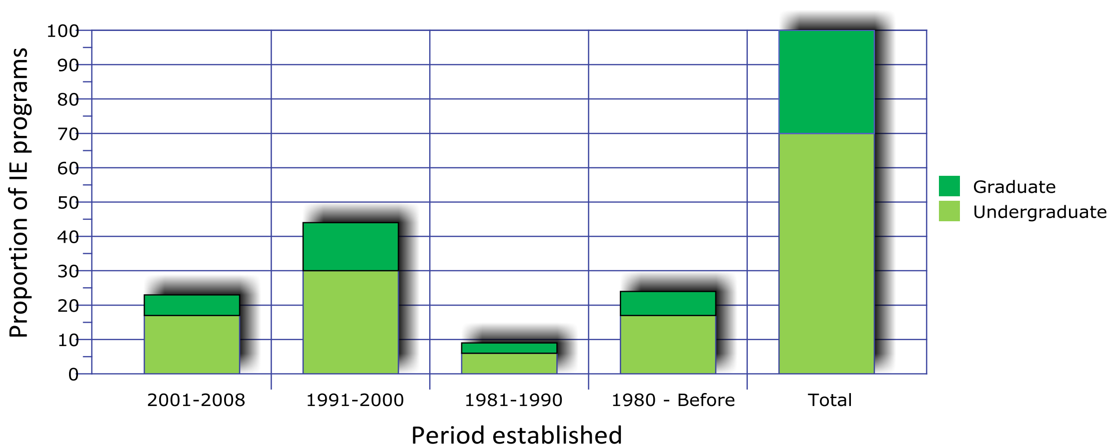
Figure 3. Distribution of degree types



Interdisciplinary Environmental Program Growth

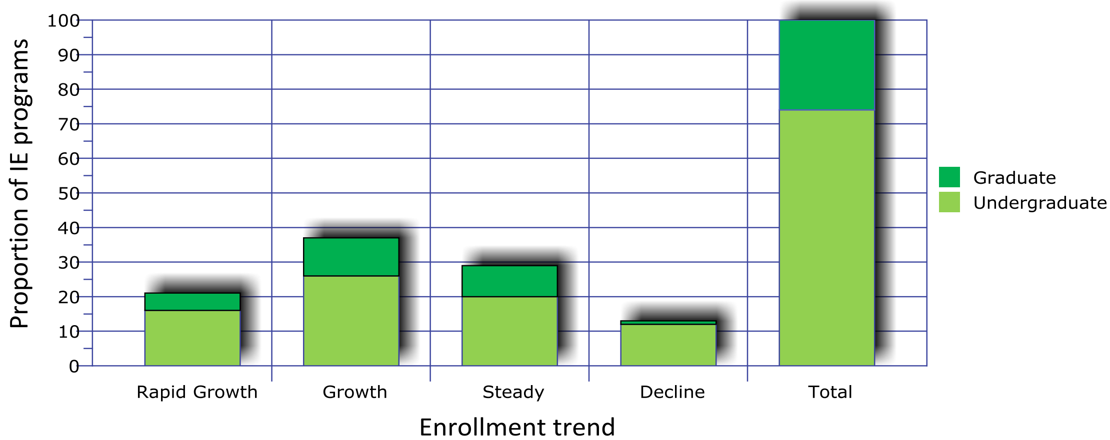
Both the number of IE degree programs and the number of students enrolled in these programs have experienced dramatic growth since 2000. About a quarter of the IE degree-granting programs in the United States were established in the last decade, and approximately two-thirds since 1990 (Figure 4). The 2009 National Wildlife Foundation's *State of the Campus Environment* report indicates that the percentage of 4-year institutions offering environmental degrees is 44%, indicating a potential increase of 4% (approximately 35 degree programs) since 2007 when the census count was conducted.

Figure 4. Period IE degree-granting programs established



The majority of programs also report growing enrollments; 58% report a growth trend in enrollment from 2003-08 and another 29% reported steady enrollment for that period (Figure 5).[13] Recent media reports indicate that this growth trend is accelerating.[14]

Figure 5. IE program enrollment trends



Program Growth Associated with Certain Degree Program Objectives and Inclusion of Sustainability in Degree Program Curricula

Notably, increases in program enrollments are significantly associated with four degree program objectives and with four forms of sustainability inclusion in program curricula. The survey included questions asking the respondents to select degree program objectives from a list of possible objectives and to select sustainability inclusion methods from a list of possible methods for each degree their program offers.[15] Respondents were also asked to indicate the enrollment trend from 2003-08 for each degree. KWANOVA analysis of variance tests reveal that the 5-year enrollment trend for undergraduate programs is significantly and positively associated with three program objectives—preparing students to be leaders and change agents, advancing environmental research, and providing community service—and with four sustainability inclusion methods—as a core principle, providing optional coursework, providing research experience opportunities, and providing service or applied learning opportunities (Tables 10 and 11). Enrollment growth in graduate programs is significantly and positively associated with one program objective—improving policy decisions (Tables 10 and 11).

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[13] 12% of undergraduate programs, 74% of masters programs, and 88% of doctoral programs limit the numbers of students they admit to their degree programs based upon available positions and/or applicant qualifications. These constraints appear to negatively affect growth for some graduate programs since most of the graduate programs reporting declining or steady enrollments indicated they are unable to accept more students.

[14] "As Colleges Add Green Majors and Minors, Classes Fill Up," *USA Today*, December 28, 2009; "Sustainability Comes of Age," *New York Times*, December 29, 2009; "Green Degrees in Bloom," *Newsweek-Kaplan College Guide*, August 12, 2009; "Students Flocking to Sustainability Degrees, Careers," *USA Today*, August 3, 2009.

[15] See Appendix E.

Table 10. IE degree program objectives and sustainability inclusion methods relationships to enrollment trends

Program objective	Rapid growth	Growth	Steady	Decline
	Enrollment trend (proportion of programs within each trend category)			
Improve policy decisions (graduate)	77%	81%	77%	20%
Prepare leaders & change agents (undergraduate)	78%	66%	54%	55%
Advance environmental research (undergraduate)	64%	48%	45%	33%
Provide community service (undergraduate)	69%	61%	43%	43%
Sustainability inclusion				
Core principle (undergraduate)	47%	33%	30%	10%
Research experiences (undergraduate)	42%	22%	22%	5%
Applied/service learning experiences (undergraduate)	44%	35%	24%	18%
Optional coursework (undergraduate)	51%	28%	27%	23%

Undergraduate programs *n*=251, graduate programs *n*=92.

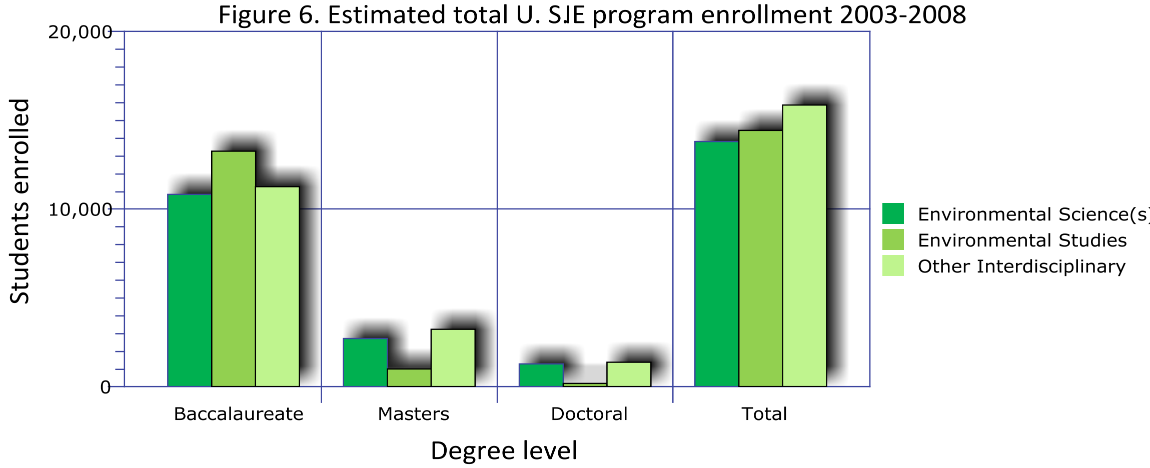
Table 11. KWANOVA tests for significant differences in enrollment trend for programs with certain program objectives and sustainability inclusion methods

Program objective	KWANOVA test
Improve policy decisions (graduate)	H(3)=8.82, p<.05
Prepare leaders & change agents (undergraduate)	H(3)=9.23, p<.05
Advance environmental research (undergraduate)	H(3)=9.48, p<.05
Provide community service (undergraduate)	H(3)=11.84, p<.05
Sustainability inclusion	
Core principle (undergraduate)	H(3)=15.01, p<.05
Optional coursework (undergraduate)	H(3)=12.29, p<.05
Research experiences (undergraduate)	H(3)=17.88, p<.001
Applied/service learning experiences (undergraduate)	H(3)=9.57, p<.05

Estimated Interdisciplinary Environmental Program Enrollment 2003-08

The number of students enrolled in IE programs and for the period 2003-2008 may be roughly estimated by multiplying the mean enrollment data from the survey by the number of programs indentified in the national program census.[16] This extrapolation indicates that approximately 44,000 students were enrolled in IE programs per year during the years 2003-2008; with approximately 10,000 of these in graduate programs (Figure 6).

Figure 6. Estimated total U. SJE program enrollment 2003-2008



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[16] Baccalaureate environmental science(s) μ=29, *n*=373; environmental studies μ =52, *n*=255; other = μ 64, *n*=176; master's environmental science(s) μ = 26, *n*=104; environmental studies μ =33, *n*=30; other μ =25, *n*=129; doctoral environmental science(s) μ =24, *n*=53; environmental studies μ =29, *n*=6; other μ =24, *n*=57.

CHAPTER V

INTERDICIPLINARY ENVIRONMENTAL PROGRAM ADMINISTRATORS' PERSPECTIVES ON CURRICULUM DESIGN

Research Question

The first phase of the curriculum study was designed to answer the first research question: determine the number of perspectives on environmental program curriculum design that program administrators hold, how these perspectives differ, and what they have in common. The contents of this chapter are excerpted from: Vincent, Shirley and Will Focht. 2009. U. S. Higher Education Environmental Program Managers' Perspectives on Curriculum Design and Core Competencies: Implications for Sustainability as a Guiding Framework. *International Journal of Sustainability in Higher Education* 10(2): 164-183, with the permission of the journal.

Methodology

Q methodology is a technique for systematically revealing the subjective, lived experiences of individuals. It is widely used as a research tool, especially in psychology and the social sciences (Brown 1980, Durning 1999, Watts and Stenner 2005). Q methodology allows researchers to identify perspectives about a particular topic, provide insight into the attributes of these perspectives, explicitly outline areas of consensus and conflict, and assist in developing shared views (for examples see Steelman and Maguire 1999, Popovich and Popovich 2000, Webler et al. 2001, Focht 2002). It is widely recognized for its value in combining quantitative and qualitative research, providing a bridge between the two research traditions.

William Stephenson, a British physicist-psychologist, developed Q methodology and first proposed that conventional factor analysis could be "inverted" to correlate people instead of traits in an article published in *Nature* in 1935 (Stephenson 1935). In other words, individuals (the P-sample) are correlated across a sample of statements (the Q-sample) that they rank (sort) in a defined order according to their view on a particular topic. Thus, the unit of analysis is the individual rather than a population, and reveals patterns of responses of individuals to a particular topic (the condition of instruction). The Q sorts are factor analyzed using centroid extraction (Varimax) and manual rotation to explore shared perspectives revealed by the sorts (Brown 1993 is an excellent primer on Q methodology).

Q methodology is not simply an inverted R methodology, but rather implies the correlation and factoring of persons rather than the correlation and factoring of traits. It does not yield statistically generalizable results, but instead produces an in-depth understanding of the perspectives that prevail about a given situation. Q methodology was thus preferred by us to learn how program managers view curriculum design because of its value in revealing insights unattainable through other statistical methods.

The Q methodology study was conducted in two steps: (1) an online survey to obtain opinions on curricular design and program characteristics, and (2) an online Q sorting exercise to ascertain perspectives on curricular design and to access conflicts and characterize the nature of debate.

The Q-sample. The statements sorted by the program administrators (the Q-sample) were drawn from responses to an online survey of 61 CEDD members (environmental program administrators) representing programs at 57 institutions of higher education. A total of 47 statements were selected from the responses to survey questions about curriculum design, such as the need for core competencies and the nature of such competencies, how curricula should be structured, what disciplinary content should be included, the role that constituencies (such as students, donors, and employers) should play in curriculum development, the importance of defining boundaries for the environmental profession, the importance of developing guidelines for professional certification, and differences in graduate and undergraduate curricula (see Appendix B for the survey questionnaire).

We used structured sampling to select the Q-sample statements to assure that they covered the full range of views expressed by the respondents and avoid biases that could result from over-sampling or under-sampling particular areas (McKeown and Thomas 1988, 28-29). Some statements were edited to enhance clarity (see Appendix C for the list of statements).

The P-sample. All program managers who participated in the online survey were asked to complete the Q sorting exercise. A total of 44 CEDD members representing 42 institutions completed the sorting exercise.

The Q-sort exercise. The Q-sort is the process through which an individual models her/his own point of view about a subject by rank-ordering the statements (Q-sample) along a continuum from 'most like my view" to "most unlike my view," typically with fewer statements allowed at the ends and more statements allowed in the middle. Statements placed in the middle of the forced distribution represent those about which the sorter feels less strongly and therefore are less salient.

In our exercise, program administrators were asked to sort the 47 statements on curriculum design based on the condition of instruction: "What is your view of how environmental program curricula should be designed?" To accomplish the sort, they entered the numbers of the statements on a score sheet with 11 columns (numbered -5 to +5, with the positive end representing "most like my view") with rows arranged in a triangular distribution as follows: 2-3-4-5-6-7-6-5-4-3-2 (see Appendix D for the Q sort form board). The placement of statements on the form board indicates the salience of the item to the individual view of the situation (from 0 "no salience" to ±5 "highest salience") and the direction (from "most unlike my view" to "most like my view").

The Q-sort protocol and detailed instructions were provided to CEDD members via email. Members were given the option of completing the Q sort online or mailing completed sorts to the researcher.

Q-factor analysis. Statement placements (-5 to +5) for each individual's Q sort were analyzed using *PQMethod*, the PC version of *QMethod*, a Q-factor analysis program originally developed by John Atkinson at Kent State University in 1992 and now maintained by Peter Schmolk at the Leibniz Supercomputing Centre of the Bavarian Academy of Sciences and Humanities in Germany. Eight centroid factors were extracted initially and examined for the number of sorts (representing an individuals' view) that significantly loaded on them ($p < 0.001$). Based on this examination, we retained three factors (A, B, and C) for rotation, which accounted for 40 of the 44 sorts.

In the first rotation, we sought to avoid bipolar loadings (Varimax rotation). That is to say, we rotated factors so that no pair of sorts significantly loaded on the opposite ends of the three factors. We found that Factor C was most unique (the least correlated with the other factors).

Manual rotation can provide additional insights into perspectives. Because Factor A and B exhibited a level of correlation higher than Factor C, we chose to rotate Factors A and B to understand their shared view. In this rotation, we sought to explore the possibility of consensus by rotating Factor A -44 degrees to the middle of the group of sorts originally bounded by Factors A and B. The rotation produced two new factors labeled A′ and B′. Factor A′ accounted for all but 7 of these original 34 factors A and B sorts as well as 2 sorts that had originally loaded on Factor C. Factor A′ thus represents a majority view shared by most of administrators (86% of all individuals' sorts loaded significantly). The B′ factor is not discussed because only three sorts loaded on this factor indicating that it does not represent a primary viewpoint on curriculum design.

Q-factor interpretation. The common (average) sort corresponding to each factor was interpreted by studying how the 47 statements are arranged, which is understood to represent the perspective shared by those program managers whose sorts loaded significantly on the factor. The initial interpretation is developed by paying particular attention to high salience statements ranked at the extremes (±5). The interpretation is refined first by examining statements judged as less salient and then through a comparison against the common sorts revealed by the other two factors (see Appendix E for the Q analysis results). Finally, our interpretation is validated by re-examining the survey responses of those program managers whose sorts significantly loaded on the factor.

Perspectives on Curriculum Design and Program Objectives

The perspectives revealed by the factors were given descriptive names that refer to educational objectives expressed by the perspective. From the first rotation, the Factor A perspective was labeled *Environmental Citizen,* Factor B was labeled *Environmental Problem Solver,* and Factor C was labeled *Environmental Scientist*. These three factors represent differing, but not opposing views on curriculum design. From the second rotation, the Factor A′ perspective was labeled *Environmental Integrator.* This factor represents a majority perspective on curriculum design.

Table 12 presents the common Q-sort placements of those statements that best discriminate these perspectives from each other. The placements range from -5 to +5 with -5 indicating "most unlike my view" and +5 "most like my view". A score of 0 indicates a statement with "no salience to my view".

Table 12. Selected Q-sample statements that best discriminate factors A, B, C, and A′

Item	Statement	A	B	C	A′
1.	Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.	0	-4	4	-2
2.	The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.	2	0	-3	2
3.	Environmental issues inherently transcend traditional disciplinary boundaries; therefore, environmental education should address problems in a way that goes beyond disciplinary thinking.	5	4	2	5
4.	Programs need to be somewhat tailored to the strengths of a given institution.	3	1	2	2
5.	Students must understand the human contexts—cultural, historical, philosophical, and ethical—of environmental issues.	5	4	1	4
6.	All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.	4	1	5	2
7.	Traditional disciplinary programs have developed core competencies; environmental programs should do the same.	-1	-2	3	-3
8.	There is a foundation of knowledge and skills that are central to understanding and solving environmental problems. These need to be incorporated into all programs.	0	-2	5	-1
9.	Academics need the reality checks that can be provided by people outside the academy. Those who are the consumers of the talent pool, who seek a valuable educational experience, and who invest in the enterprise of education all have valuable insights.	-1	2	1	0
11.	Undergraduate programs should have a research-based graduate school preparation track and a practical applications-based professional track.	-5	-2	-3	-5
12.	Systems understanding, recognition of emergent properties, synthesized knowledge, and "thinking outside the box" are important goals of environmental education.	2	4	1	3
14.	Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.	-4	-2	1	-3
19.	One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.	4	5	4	5

Table 12. Selected Q-sample statements that best discriminate factors A, B, C, and A′ (continued)

Item	Statement	A	B	C	A′
22.	It is important to include various clients in program development and planning to stay connected with market employment needs and evolving environmental concerns.	-2	2	0	0
24.	Because of the youth of the field and its interdisciplinary nature, core competencies for environmental programs should be sufficiently broad to encompass a variety of different approaches.	0	1	-1	1
25.	Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.	-4	-3	3	-4
26.	The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.	1	3	0	1
33.	Environmental decisions should be made rationally. Students should learn decision theory techniques such as benefit/cost analysis, risk analysis or other optimization strategies.	4	5	4	1
34.	It is essential for students to understand the interface between nature and social systems—how societies impact the environment and how the environment impacts societies.	4	5	4	4
35.	Client involvement is important for program support and overall success.	-3	1	-1	-1
37.	Undergraduate preparation for graduate school or an immediate career should be the same to prepare students for life-long learning and critical thinking.	1	1	0	2
38.	Client interests are not always compatible with academic goals. It's the faculty's prerogative to develop curricula, not the clients.	3	-3	-2	0
39.	Students need to understand the limits of scientific studies and learn to appreciate, quantify, and accurately report uncertainties.	2	3	3	3
40.	It is important for students to gain an understanding of environmental conflicts between competing interests, such as utilitarian versus preservationist, individual versus public, local versus global, and current versus future generations.	3	3	0	3
41.	It is important that all students have exposure to a broad range of subjects, including the humanities and the natural, social, and applied sciences.	2	3	2	4
43.	Hard boundaries limit the perspectives that can be brought to bear on environmental problems, which require interdisciplinary solutions.	-1	0	-1	1

Four themes differentiate these first three perspectives: (1) orientation to curriculum design (liberal arts versus professional training), (2) preference for including external constituencies in curriculum design (such as employers and/or alumni), (3) curriculum breadth versus depth, and (4) fixed versus flexible core competencies.

Environmental Citizen Perspective (Factor A)

Orientation to curriculum design – liberal arts. The *Environmental Citizen* perspective, popular in baccalaureate liberal arts institutions, focuses on training students to be environmentally aware citizens who can be effective environmental advocates in whatever career they choose (Items 2, 25).

Involvement of external constituencies in curriculum design – oppose. Environmental Citizens express wariness or opposition to the involvement of constituencies outside the academy (Items 22, 35, 38). One program manager offered this comment: "I would argue that the students are important, but the curriculum must belong to the faculty and not be dictated by external groups."

Curriculum breadth versus depth – breadth with emphasis on the social sciences. Environmental Citizens favor curricular breadth that includes the natural sciences (Item 6), the humanities (Item 5), and political and social aspects of environmental problems (Item 40). This perspective, while supporting an interdisciplinary curriculum (Item 3), is more neutral (or ambiguous) about the need for depth in a specific discipline or specialization area (Item 1). In contrast, the other two perspectives strongly reject (Factor B) or affirm (Factor C) the need for depth. *Environmental Citizens* view the social sciences as particularly important for environmental curricula, especially policy, law, and economics. A program manager holding this perspective said, "Of particular relevance are the fields of political science, law, and economics; these disciplines, along with sociology, are keys to understanding the human dimensions of environmental challenges."

Core competencies – flexible and tailored. Environmental Citizens are opposed to placing overly prescriptive limitations on programs via strictly defined core curricula and are wary of establishing environmental program boundaries (Items 8, 14, 43). In their comments, they indicated that they want core competencies to be flexible enough to adapt to the rapidly evolving environmental field, permit responsive program design, and ensure programs remain broad and inclusive. They also believe that programs should be tailored to institutional strengths (Item 4) and that core competencies should "not prevent different institutions from designing their programs to take advantage of different strengths and to emphasize particular aspects of environmental education."

Environmental Problem Solver Perspective (Factor B)

Orientation to curriculum design – professional training. The *Environmental Problem Solver's* orientation to curriculum design is educating environmental professionals to solve environmental problems. Those holding this perspective believe that environmental programs should focus on training environmental professionals who can utilize systems-focused approaches and draw upon insights and tools from all relevant disciplines to address complex environmental issues (Items 3, 12). One *Environmental Problem Solver* stated that "Systems understanding, recognition of emergent properties, synthesized knowledge, and 'thinking outside the box" are important goals of environmental professional training."

Involvement of external constituencies in curriculum design – strongly favor. Two distinctive characteristics of this perspective are strong support for external constituency involvement in curriculum design (Items 9, 22, 35, 38) and program flexibility (Item 26) to allow programs to respond to changing marketplace conditions and evolving environmental problems. Several *Environmental Problem Solvers* commented on the benefits of students working directly with constituencies (such as employers and non-governmental organizations) via internships, service learning, and other types of collaboration.

Curricular breadth versus depth – breadth with emphasis on interdisciplinary skills. This perspective strongly favors breadth over depth with an emphasis on interdisciplinary skills (Items 1, 3, 12). *Environmental Problem Solvers* stress the importance of all relevant disciplinary areas, especially the sociopolitical aspects of environmental issues and the humanities (Items 5, 19, 34). In their comments, they emphasize the importance of understanding differing epistemological approaches, as well as the ethical, historical, and cultural contexts of environmental issues. *Environmental Problem Solvers* also view business, engineering, and decision sciences (Item 33) as important components of environmental curricula. They place less importance on science literacy than the other two perspectives (Item 6).

Core competencies – flexible and dynamic. Congruent with the *Environmental Citizen* perspective, those holding the *Environmental Problem Solver* perspective are wary of overly prescriptive program boundaries (Item 14) and core competencies. They are wary of the idea that there is a foundation of knowledge and skills central to understanding and solving environmental problems that should be applied to all programs (Item 8). However, they support defining core competencies as long as they are flexible and dynamic enough to adapt to the constantly evolving environmental field (Items 24, 26).

Environmental Scientist Perspective (Factor C)

Orientation to curriculum design –professional scientist training. This perspective focuses on training specialists, such as scientists and engineers, who can devise practical solutions to environmental problems. Less emphasis is placed on the importance of the human contexts of environmental problems (Items 5, 40) and more emphasis is placed on decision science, engineering, and business (Items 33, 41).

Involvement of external constituencies in curriculum design – favor. Environmental Scientists are less committed to constituency involvement in curriculum design but their comments indicate they support training that meets employers' expectations (Items 9, 22, 35, 38).

Curricular breadth versus depth – deep strength in a discipline required. Environmental Scientists support an interdisciplinary curriculum, but emphasize depth over breadth (Items 1, 2, 3, 12). They favor deep strength in a disciplinary area with branches reaching out to allied disciplines.

Core competencies – universal core grounded in natural science. Another distinctive characteristic of this perspective is its staunch support for establishing a universal core (Items 7,

25) grounded in the natural sciences (Item 6). In contrast to the other two perspectives, *Environmental Scientists* assert that a common foundation of knowledge and skills is essential to understanding and solving environmental problems (Item 8).

Environmental Integrator Perspective (Factor A′)

Orientation to curriculum design – disciplinary synthesis. This majority perspective's orientation to curriculum design is focused on disciplinary synthesis—ensuring that environmental programs provide students with the breadth of knowledge and critical thinking/synthesis skills required to understand the complexity of environmental issues and effectively devise and initiate innovative solutions for solving environmental problems (Items 3, 12).

They oppose undergraduate tracking that would limit future options, believing that no curricular distinction should be made between students planning immediate professional careers versus graduate school (Items 11, 37).

Involvement of external constituencies in curriculum design – neutral. The position of *Environmental Integrators* is neutral regarding the involvement of constituencies outside of the academy (Items 9, 22, 35, 38).

Curricular breadth versus depth – breadth with emphasis on human contexts. Environmental Integrators support curricular breadth with an emphasis on disciplinary synthesis and the human dimensions of environmental issues (Items 5, 19, 34). Humanities and social sciences are as important as natural sciences (Items 40, 41). Less emphasis, however, is placed on business and engineering. Science literacy, including the ability to understand the limits of scientific studies and accurately report uncertainties, is moderately important (Items 6, 39).

Core competencies – flexible, dynamic and tailored. Environmental Integrators do not view defined boundaries for environmental programs favorably because boundaries can limit the perspectives that can be brought to bear on environmental issues (Items 14, 43). They favor a flexible, dynamic set of core competencies as long as they are adaptable enough to allow for program evolution and creativity (Items 24, 26) and flexible enough to be tailored to individual institutions and programs (Item 4).

Parallels to Ideologies Regarding Program Objectives

The three first-rotation perspectives revealed by the Q analysis manifest different—but not opposing—views of the appropriate objectives for environmental programs and orientations to curriculum design. They closely parallel ideologies advocated in environmental education literature: *citizen awareness, environmental managerialism,* and *environmental specialization.*

Proponents of citizen awareness support a broad liberal arts approach and reject career-focused training (Weis 1992, Strauss 1995, Hornig 1996, Romero 2003). They believe students in all fields need to develop environmental literacy to become "caring and competent stewards of the environment" (Strauss 1995, ix).and that environmental/sustainability education should be infused into all higher education disciplines (Weis 1992, Orr 1995). "The best measure of the success of environmental programs [is] the number of physicians, lawyers, businessmen, or politicians who reflect the values and worldview of an IE studies program" (Hornig 1996, 3).

Advocates of the managerialist ideology prefer that environmental programs train environmental managers and scholars in the use of interdisciplinary approaches to solve environmental problems and effectively influence environmental management decisions and policy. In this view, holistic disciplinary synthesis is more important than depth in training graduates for environmental careers (Lynch and Hutchinson 1992, Thomas 1992, Andersen, Worthen and Polkinghorn 2001). Competence requires the "integration of knowledge…with problem-solving and ways of dealing with people and complex organizations" (Thomas 1992, 261). Lynch and Hutchinson (1992, 864) contend that environmental challenges require "authoritative environmental managership in the form of dedicated practitioners across the organizational landscape" and that a new environmental profession is needed to synthesize the diverse branches of environmental knowledge and research into a whole, define a suitable environmental ethic relative to the environment, develop competent practice of environmental management in government and industry, and maintain vigorous, independent research efforts focused on emerging problems. Andersen, Worthen and Polkinghorn (2001, 202) argue that solutions to environmental problems are not developed by scientists, but by "politicians, economists, theologians, philosophers, engineers and society as a whole—each with different epistemologies, methods, and value systems" and that environmental programs should train environmental professionals who can evaluate environmental problems in their cultural and social contexts. Therefore, environmental programs should train broad, holistic, and systemic thinkers who can fulfill roles akin to that of a conductor. In a collaborative setting involving disciplinary experts, environmental professionals should serve to bridge the gaps, orchestrate the collaboration, and provide an overarching vision.

Contrary to the awareness and managerialist ideologies, the specialist ideology advocates curricular depth in a specific discipline as a requirement for professional employment (Braddock, Fein and Rickson 1994, Soule and Press 1998). Environmental programs should train professional specialists to apply disciplinary tools to solve environmental problems. Strength in a traditional discipline is required to combat "multidisciplinary illiteracy" and contribute to solving environmental problems (Soule and Press 1998). They contend that "without curricular depth and coherence [environmental] programs can fail by any standard of academic excellence" (Soule and Press 1998, 404). Instead of breadth, they recommend that environmental study be combined with another field of study, preferably as a double major. Braddock, Fein and Rickson (1994) suggest environmental program graduates do not fare as well as traditional graduates in finding employment because most entry-level positions in government and industry require a specific disciplinary background. They argue that people making hiring and promotion decisions are more likely to hire a graduate from a traditional discipline; while graduates without strong disciplinary training are often hired into positions handling communications with government agencies or community groups or in low-status departments within organizational hierarchies. In summary, the specialist ideology sees curriculum breadth as important primarily for effective communication of scientific knowledge to team members, decision-makers, and the public.

Perspectives on Curriculum Design Related to Institution Type

Linear regression analysis was used to explore the relationship between program administrators' institutional Carnegie classification and their curriculum perspectives.[17] The results confirm this relationship for administrators loading on Factor A – *Environmental Citizen* perspective [$F_{(2,41)}$ = 3.643; $p<0.05$] and Factor C – *Environmental Scientist* perspective [$F_{(2,41)}$ = 4.894; $p<0.05$]. Those managers loading on Factor B – *Environmental Problem Solver* perspective [$F_{(2,41)}$ = 2.752; ns] are not predicted by their host institutions' Carnegie classification due to the mix of *Environmental Problem Solvers* and *Environmental Citizens* located at doctoral institutions.

Though a statistically significant relationship exists between Carnegie classification and curriculum perspective for two of the three perspectives, the regression coefficients prove that the magnitude of the influence of institution class on perspectives is relatively low. Only 15% of the variance in factor loadings on Factor A and 19% on Factor C were predicted by the Carnegie classification of the program administrators' institutions (Table 13).[18]

Table 13. Results of multiple regression of institution influence on factor scores

Factor A – Environmental Citizen Perspective

R^2= 0.151; significant; $p<0.05$ Regression Equation: $Y' = 0.360 + 0.137X_1 - 0.157X_2$ $Y'_B = 0.360 + 0.137(1) - 0.157(0) = 0.497$ $Y'_M = 0.360 + 0.137(0) - 0.157(1) = 0.203$ $Y'_D = 0.360 + 0.137(-1) - 0.157(-1) = 0.380$ Mean $Score_B = 0.497$ Mean $Score_M = 0.203$ Mean $Score_D = 0.380$	Post Hoc Scheffe Analysis of Significance of Mean Differences B and M = 0.497(1) + 0.203(-1)= 0.294 M and D = 0.203(1) + 0.380(-1) = -0.177 B and D = 0.497(1) + 0.380(-1)= 0.117 *MSR = .055; F(.05, 2, 41) = 3.23* S_{BM} = 0.277; significant at $p<0.05$ S_{MD} = 0.241; not significant S_{BD} = 0.216; not significant

[17] The regression was performed with institution type as the categorical independent variable coded as (baccalaureate, masters, and doctoral) and (factor loading) as the interval dependent variable. Effect coding was used to adjust results due to unequal institution sample sizes: 11 baccalaureate, 8 masters, and 23 doctoral (total = 44). Three regressions were conducted, one for each of the factors, utilizing SPSS 12.0 software.

[18] Scheffe post-hoc tests of institutional class differences confirm that significant differential effects exist when contrasting baccalaureate and masters institutions on Factors A and C ($p<0.05$) and masters and doctoral institutions on Factor C ($p<0.05$).

Table 13. Results of multiple regression of institution influence on factor scores (continued)

Factor B – Environmental Problem Solver Perspective	
R^2 = 0.118; not significant Regression Equation: $Y' = 0.326 - 0.006X_1 - 0.097X_2$ $Y'_B = 0.326 - 0.006(1) - 0.097(0) = 0.320$ $Y'_M = 0.326 - 0.006(0) - 0.097(1) = 0.229$ $Y'_D = 0.326 - 0.006(-1) - 0.097(-1) = 0.429$ Mean $Score_B$ = 0.320 Mean $Score_M$ = 0.229 Mean $Score_D$ = 0.429	Post Hoc Scheffe Analysis of Significance of Mean Differences B and M = 0.320(1) + 0.229(-1) = 0.091 M and D = 0.229(1) + 0.429(-1)= -0.200 B and D = 0.320(1) + 0.429(-1) = -0.109 *MSR = .055; F(.05, 2, 41) = 3.23* S_{BM} = 0.261; not significant S_{MD} = 0.228; not significant S_{BD} = 0.203; not significant
Factor C – Environmental Scientist Perspective	
R^2= .193; significant; $p<0.05$ Regression Equation: $Y' = 0.317 - 0.109X_1 + 0.198X_2$ $Y'_B = 0.360 - 0.109(1) + 0.198(0) = .208$ $Y'_M = 0.360 - 0.109(0) + 0.198(1) = .515$ $Y'_D = 0.360 - 0.109(-1) + 0.198(-1) = .228$ Mean $Score_B$ = 0.208 Mean $Score_M$ = 0.515 Mean $Score_D$ = 0.228	Post Hoc Scheffe Analysis of Significance of Mean Differences B and M = 0.208(1) + 0.515(-1) = -0.307 M and D = 0.515(1) + 0.228(-1)= 0.287 B and D = 0.208(1) + 0.228(-1)= -0.020 *MSR = .055; F(.05, 2, 41) = 3.23* S_{BM} = 0.284; significant at $p<0.05$ S_{MD} = 0.248; significant at $p<0.05$ S_{BD} = 0.221; not significant

Consensus Perspective on Program Identity and Majority Consensus on Curriculum Design

The statements in Table 14 reveal a consensus view among the three first-rotation perspectives on interdisciplinarity, as confirmed by the majority *Environmental Integrator* perspective (Factor A′) obtained from the second rotation.

Table 14. Consensus Q sample statements

Item	Statement	A	B	C	A′
19.	One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.	4	5	4	5
34.	It is essential for students to understand the interface between nature and social systems—how societies impact the environment and how the environment impacts societies.	4	5	4	4
3.	Environmental issues inherently transcend disciplinary boundaries; therefore, environmental education should address problems in a way that goes beyond disciplinary thinking.	5	4	1	5
41.	It is important that all students have exposure to a broad range of subjects, including the humanities and the natural, social, and applied sciences.	2	3	2	4

Table 14. Consensus Q sample statements (continued)

Item	Statement	A	B	C	A′
12.	Systems understanding, recognition of emergent properties, synthesized knowledge, and "thinking outside the box" are important goals of environmental education.	2	4	1	3
39.	Students need to understand the limits of scientific studies and learn to appreciate, quantify, and accurately report uncertainties.	2	3	3	3
20.	Environmental education should continue to follow its traditional focus on a providing depth in a single discipline.	-4	-5	-2	-5
45.	The environmental profession is still evolving and it's too early to develop highly defined boundaries.	-1	-1	-3	-1

Program administrators agree that environmental problems lie at the interface between human and natural systems; therefore, environmental programs should provide students with an understanding of both the sociopolitical and natural aspects of environmental problems (Items 19, 34). There is also agreement that the complexity of environmental issues requires that programs employ an interdisciplinary educational approach (Items 3, 20) and that analytic skills should include systems thinking and synthesis in order to devise innovative solutions for pressing environmental problems (Item 12). Administrators also agree that students should receive exposure to a range of disciplines, including those in the humanities and the social/natural sciences, and should understand the limitations of science and the relevancy of uncertainty (Items 39, 41). Finally, all agree that the environmental profession has matured enough to identify some sort of boundaries (Item 45).

The environmental education literature supports the finding that environmental programs provide an *interdisciplinary focus on the interface of social and natural systems* (Caldwell 1983, Sacks and Davis 1983, Fletcher 1992, Orr 1995, Andersen, Worthen and Polkinghorn 2001). There is also broad consensus that solving environmental problems requires a holistic approach and environmental scholars, professionals, and scientists should be trained to be systematic, process-oriented thinkers capable of understanding complex nature-society relationships (Thomas 1992, Hornig 1996, Foster 1999, Pfirman and the AC-ERE 2003).

Caldwell (1983) argues that it is the *process* of integrating and synthesizing knowledge that distinguishes the environmental field from traditional disciplines and environmental studies is best described as a *metadiscipline* because it focuses many disciplines on an *integrating concept*: the interactions of humans and their environment. He explains that in a metadisciplinary approach, derivative knowledge from relevant disciplines is "synthesized to form new information and insights not directly deducible from any one of the disciplines." The challenge for environmental programs is to develop a metadisciplinary curriculum that "transcend multi- or interdisciplinary approaches to arrive at a metadiscipline which rest[s] upon a coherent body of theory regarding environmental relationships" (Caldwell 1983, 257). Thomas (1992) supports this process-oriented view of the environmental field and argues that interdisciplinary programs should not aim for coverage of a huge range of subjects, but instead should emphasize the process of synthesis, integration, and analysis across disciplines.

Table 15 presents a summary of the salient features of the four perspectives.

Table 15. Perspective characteristics

Characteristic	Environmental citizen	Environmental problem solver	Environmental scientist	Environmental integrator
Orientation – educational goal	Liberal arts education	Professional training	Professional training of disciplinary specialists	Creative thinkers
Constituency involvement	Student oriented	Employer oriented	Employer oriented	Neutral
Educational approach	Curricular breadth, emphasize social sciences	Curricular breadth, emphasize humanities, social sciences, management	Curricular depth, emphasize natural and applied sciences	Curricular breadth, emphasize humanities and social science
Core competencies	Broad and flexible	Broad and flexible	Defined and universal	Broad and flexible

Implications for Sustainability as a Guiding Framework

IE degree programs in the United States evolved in response to internal influences within the universities and colleges hosting the programs and external forces such as societal changes and the economy. Today, climate change and other complex global environmental problems are driving a global movement toward sustainable development and creating significant demand for both existing and new types of sustainability and environmental professionals.

Sustainability is emerging as a new framework in many higher education programs. Despite ambiguity surrounding the definition of sustainability and tensions between varying concepts of environmental education and sustainability education, a consensus is forming that environmental education should be oriented toward sustainability (Cortese 1992, Bonnett 1999. Rest 2002, McKeown and Hopkins 2003, Mihelcic et al. 2003, Smyth 2006).

After the idea of sustainable development entered the public lexicon in 1987, a new wave of rapid environmental program proliferation began (Manning 1999, Maniates and Whissel 2000, Romero and Jones 2003). The renewed interest in environmental programs is tied to increasing awareness of the complex challenges posed by global environmental issues and achieving sustainable futures. These newly created programs (as well as many realigned existing programs) have renewed their attention on the social, political, ecological and technological contexts of environmental issues combined with a new emphasis on complexity, systems understanding, and the relevance of temporal and spatial scales (Rest 2002). The evolution of the concept of sustainability, rapid growth of ecosystem and social system knowledge, expanding Internet technologies, and the emergence of new interdisciplinary research approaches are sustaining the momentum toward systems-oriented approaches to the examination of environmental issues. Concomitantly, the recognition of the importance of cultural, social, and political aspects of environmental problems in education and research has also increased dramatically (Bonnett 1999, Romero 2003, Ginsberg, Doyle and Cook 2004).

A new term, sustainability science, has been coined to describe an emerging field of research dealing with the interactions between natural and social systems, and how those interactions affect sustainability. Sustainability science is described as science dedicated to improving the human condition. It is place-based and integrative and bridges (1) the natural, social, and applied sciences; (2) multiple sectors of human activity; (3) geographic and temporal scales; and (4) various communities engaged in promoting ecological and human health, conservation and economic development. It addresses the fundamental questions regarding the interrelationships of scale, non-linear processes, and complexity, as well as the unity of nature and society (Kates et al. 2001). There is clear alignment of this emerging view of science for sustainability and environmental programs' renewed focus on all aspects—social, political, cultural, ecological, and technological—of environmental problems, as well as the importance of temporal and spatial scales and systems-oriented thinking.

The Q analysis found the following consensus on IE program field identity:

- IE programs should focus on the interface between human and natural systems (coupled human and natural systems).
- IE programs should adopt a holistic, interdisciplinary approach that fosters synthesis and systems-thinking skills and that the natural sciences, social sciences, applied sciences and humanities should be included in program curricula.
- Students should have an understanding of the sociopolitical and natural aspects of environmental problems, the limits of technology and science, and the importance of acknowledging and reporting uncertainty.

The characteristics of the common consensus view on IE program identity align closely the characteristics of sustainability-oriented environmental research and practice as it is commonly and widely described in the sustainability literature and in U. S. government documents pertaining to environmental education and research (U.S. Environmental Protection Agency 2007, National Science Foundation AC-ERE 2003, 2005, 2009). In addition, discussions at several workshops held at environmental science and studies conferences revealed that programs share a normative commitment to sustainability and that the goal of degree programs should be to prepare students to be sustainability-oriented scientists, leaders, problem-solvers and decision makers (Vincent and Focht, 2010). Sustainability in this context is interpreted modestly as a resilient, sustainable relationship between actions taken to improve the human condition and the natural environment. We did not attempt to define sustainability in the context of IE education since we continue to believe that students should be aware of the various ways in which sustainability is understood.

Table 16. Importance of sustainability knowledge in IE degree curricula

Importance level	Undergraduate programs (*n*=224)	Graduate programs (*n*=84)
High	41%	36%
Moderate	45%	52%
Low	13%	8%
Minimal/none	1%	4%

The centrality of the concepts of sustainability in IE programs is also evidenced by the level of importance placed on sustainability knowledge in degree curricula, and by the inclusion of sustainability in the majority of interdisciplinary degree programs. The importance of sustainability knowledge in program curricula is affirmed by its mean rating of moderately to highly important across all IE degree program types, and by the large percentage of programs that rate its importance in their degree curricula as either moderate or high (Table 16). In addition, most IE degree programs include sustainability in their curricula, with over half requiring sustainability-related coursework and over a third viewing sustainability as a core guiding principle (Table 17).

Table 17. Sustainability inclusion by degree type

Inclusion mechanism	BS (*n*=148)	BA (*n*=102)	MS (*n*=43)	MA (*n*=9)	Other Masters (*n*=14)	PhD (*n*=25)	Total (*n*=341)
Core principle	27%	38%	26%	89%	29%	16%	31%
Required coursework	57%	62%	40%	56%	43%	36%	54%
Optional coursework	23%	44%	54%	44%	57%	44%	37%
Research experiences	20%	28%	28%	44%	43%	28%	26%
Applied or service learning opportunities	27%	36%	19%	33%	29%	4%	27%
Other*	1%	0%	0%	0%	0%	0%	1%
Not included	20%	13%	19%	0%	21%	28%	18%

The results of this Q analysis of program administrators' perspectives on curriculum design suggests that the CEDD members may support the development of core competencies for IE programs and that sustainability may serve as a paradigm to guide their development. The consensus view on the core identity of environmental programs as a holistic, interdisciplinary focus on the interface between societal systems and natural systems is congruent with a focus on the ecological, societal, and economic aspects of sustainability.

Figure 7. Relationship of IE program administrators' perspectives on curriculum design

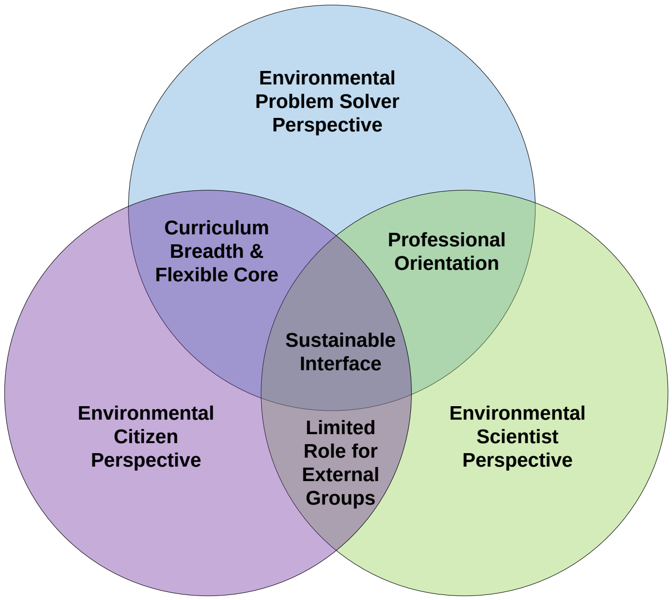


Figure 7 illustrates the overlapping relationship between the three perspectives on curriculum design and the concept of study of the human-nature systems interface and sustainability as a core consensus field identity for all IE programs.

Taken together, the results from the perspectives study, discussions at conference workshops and analyses of survey data indicate that the potential exists for forging consensus on field identity; environmental programs should focus on sustainability-oriented scholarship, research and practice through interdisciplinary problem solving.

CHAPTER VI

DIMENSIONS OF INTERDISCIPLINARY KNOWLEDGE AND SKILLS

Research Question

The second research question concerned the identity of the dimensions that underlie the inclusion of knowledge and skill areas in interdisciplinary program curricula, and how these dimensions may serve as interdisciplinary core competency areas.

Methodology

Factor analysis is a statistical method that reduces a number of interrelated variables to a smaller number of dimensions or factors, each representing a common entity or construct. It allows the researcher to discover how the responses to questions are interrelated based on correlations or covariances. The factors can then be used to create scales or measures composed of several elements and to understand the relationships between elements.

Exploratory factor analysis was conducted using the responses to questions on the respondents' views of the importance of various knowledge areas and skills in an ideal curriculum for each of the degrees their programs offer. The respondents were asked to rate the importance of 16 knowledge areas and 23 skill areas using a 4-point Likert scale arrayed from minimal/no importance, through low importance and moderate importance, to high importance. A total of 308 knowledge variable sets and 304 skills variables sets were obtained for this analysis. The analysis reduced the 39 knowledge and skill ratings into a smaller number of factors comprised of similarly rated sets of variables weighted by their relative influences on the factors. These factors thus represent potential IE program interdisciplinary core competency areas and reveal how different disciplinary knowledge areas and skills are related to each other in ideal environmental program curricula.

There are six primary steps in conducting a factor analysis. The first is to determine if the data matrix is suitable for factor analysis, second is choosing an extraction technique, third is choosing a rotation method, fourth is determining how many factors to retain, fifth is interpreting the factors (factor loadings to consider in the interpretation), and sixth is validating the factor structure (Field 2005).

The maximum likelihood factor extraction method was selected because it includes a statistical goodness-of-fit test and allows generalizations from a sample to a population of either subjects or variables, assuming that the sample is representative of the population (i.e., the sample is unbiased). We believe that we met this assumption because our program sample was shown to be representative and our population of knowledge and skill variables was vetted by relevant experts.

Five criteria can be considered when determining the number of factors to retain for interpretation. The most popular criterion is Kaiser's, which recommends retaining all factors with eigenvalues ≥ 1. We evaluated all five criteria and decided to use the Kaiser criterion.

Factor rotation is used to simplify data structures. This process rotates the factor axes such that the variables are loaded maximally on only one factor (minimizes unexplained variance). Orthogonal rotation rotates factors while keeping them independent while oblique rotation allows the factors to correlate. Oblique rotation is typically used when there is good reason to assume that the factors could be related in theoretical terms. Since we expected that some knowledge and skills factors could be related, we chose an oblique (Promax) rotation method for the primary analysis and compared the results to an orthogonal (Varimax) rotation.

The nature of each factor is interpreted using factor loadings. A factor loading is interpreted as the Pearson correlation coefficient of original variables (in this study, the importance ratings of knowledge and skill areas) with a factor. Factor loadings indicate an association of the variable with a factor and ranges from 1 (perfect positive association) to -1 (perfect negative association). The relative importance of each variable is indicated by the magnitude of the squares of the factor loadings. In social research, 0.32 is cited as a conservative value for the minimum loading of a variable on a factor because it equates to approximately 10% overlapping variance. This value was used as the critical value for this study.

The validity of the factor structure and model is established by the maximum likelihood goodness-of-fit test and by testing the reliability of each factor using Cronbach's alpha reliability coefficient (value ≥ 0.7 indicates that the variables loading on the factor are sufficiently similar). Model goodness-of-fit tests for both the knowledge factor solution and skills factor solution are equal to $p<0.001$; all of the factors were shown to be reliable. See Appendix H for additional detail on the exploratory factor analysis protocol.

Dimensions of Interdisciplinary Knowledge and Skills

Factor analysis of program administrators' ratings of the importance of 16 knowledge and 23 skill variables (for each degree offered) reveals 5 knowledge factors and 5 skill factors. Descriptive names were assigned for each factor based on the variables significantly loading on each factor and how much influence they exert. The five knowledge factors are natural sciences, natural resources, social sciences, humanities, and development (Table 18). All 16 knowledge variables were significantly loaded on at least one factor and all factors were reliable based on the Cronbach's α statistic. The factors are listed by descending order of their relative level of overall importance in IE program curricula.[19] The first factor—natural sciences—was rated of highest importance, the natural resources and social sciences factors as moderately important and the humanities and development factors of lower importance in IE program curricula.

The total amount of variance explained by the knowledge factor solution is 64%, an indication of how well the factor solution accounts for the total variance in the importance ratings. The amount of variance each factor explains is an indication of how well the factor explains the respondents' rating patterns. The factor structure indicates that rating patterns among all program administrators are best explained in terms of the natural resources factor.

Table 18. Knowledge factor solution

Knowledge factor	Variance explained	Relative importance	Variables significantly correlated	Reliability (Cronbach's α)
Natural resources	29%	2.0 (moderate)	(1) natural resources mgmt. & agriculture, (2) geography, (3) sustainability, (4) education, (5) research methods, (6) ecology	.678
Humanities	12%	1.4 (low)	(1) history, (2) language arts, (3) philosophy & ethics	.750
Social sciences	10%	1.9 (moderate)	(1) policy & public administration, (2) economics, (3) business, (4) other social sciences	.742
Natural sciences	7%	2.9 (high)	(1) life sciences, (2) physical sciences, (3) ecology	.663
Development	6%	1.3 (low)	(1) engineering & built environment, (2) business	.736

Three of the five factors—natural resources, social sciences and humanities—are highly correlated with each other, creating a knowledge competency area labeled as "coupled human-nature systems" (Tables 19 and 20).

Table 19. Knowledge factor correlation matrix

Knowledge factor	Natural Resources	Humanities	Social sciences	Natural sciences	Development
Natural resources	1.000	.521	.545	.275	.303
Humanities		1.000	.636	.112	.103
Social sciences			1.000	.128	.149
Natural sciences				1.000	-.030
Development					1.000

[19] The relative importance of each factor was calculated by multiplying the influence of each variable (the square of the correlation coefficient) with the variable mean, normalizing these values and summing them to obtain a factor importance rating.

Rotation method: Promax with Kaiser normalization

Table 20 lists the three knowledge competency areas, five knowledge factors, and knowledge variables associated with each factor and its proportional influence on the factor.

Table 20. Knowledge competency areas

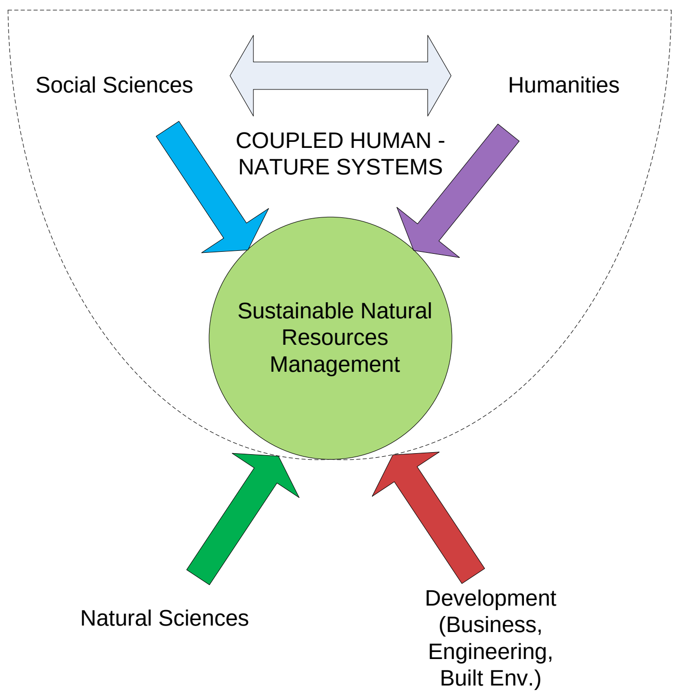
Competency area	Factor	Knowledge variable (influence/weight)
Natural sciences	Natural sciences	life sciences (60) physical sciences (27) ecology (13)
Coupled human-nature systems	Natural resources	natural resources management & agriculture (31) geography (20) sustainability (15) education (14) research methods (11) ecology (8)
	Social sciences	policy & public administration (42) economics (42) business (9) other social sciences (8)
	Humanities	history (48) language arts (31) philosophy & ethics (21)
Development	Development	engineering & built environment (73) business (27)

Given the sustainability-oriented focus of IE programs, it is important to note that the sustainability knowledge variable is associated with the natural resources factor and the coupled human-nature systems knowledge competency area.

The knowledge factor structure indicates that the sustainable stewardship of natural systems is the central focus for all IE programs (Figure 8). All four other factors are either highly (social sciences and humanities) or moderately (development and natural science) correlated with the natural resources factor (Table 19). The high importance of the natural sciences (especially the life sciences) indicates this is essential knowledge, the high level of correlation between the natural resources, social sciences and humanities factors indicate that environmental sustainability is understood through knowledge of coupled human-nature systems; and the role of business practices, engineering, and technologies that create the built environment provide additional context for understanding the coupled systems interface.

This interpretation of a generalized curriculum structure for knowledge is supported by the consensus view of field identity as an interdisciplinary focus on the human-nature systems interface Comments on the importance of different knowledge areas from the phase I survey reinforce the interpretation of the roles of the natural sciences and development factors. The majority of program administrators believe knowledge of the natural sciences is essential foundational knowledge for environmental study, and that broad exposure to engineering, technology and business concepts are important elements for understanding environmental problem solving. Surveys of environmental program graduates also indicate that an exposure to the engineering and the technological aspects of solving environmental problems are key components of environmental professional training (Barker and Graveel 2004, Hansmann 2009).

Figure 8. Knowledge factor relationships.



The five skill factors are technical research and analysis, management, cognition, community engagement, and public communications (Table 21). Two skill variables were not significantly loaded on any factor: social research and literature research—suggesting that the judged importance of these research skills are not related to the importance ratings of other skills. All factors were reliable based on the Cronbach's α statistic. The cognition factor was rated of highest importance; the technical research and analysis, community engagement and public communications factors of moderate importance and the management factor of lowest importance for IE program curricula.

The total common variance explained by the skills factor solution is 62%. The factor structure indicates that the ratings vary the least on the emphasis placed on the technical research and analysis factor, followed by the management, cognition, public communication and community engagement factors.

Table 21. Skills factor solution

Skills factor	Variance explained	Relative importance	Variables significantly loaded	Reliability (Cronbach's α)
Technical research	33%	2.3 (moderate)	(1) field research, (2) lab research, (3) mathematics, (4) statistics, (5) spatial analysis, (6) tech/academic writing, (7) oral communication	.806
Management	12%	1.4 (low)	(1) personnel mgmt, (2) project mgmt, (3) leadership, (4) decision science, (5) information management	.834
Cognition	7%	2.6 (high)	(1) synthesis, (2) problem-solving, (3) analysis, (4) creativity, (5) critical thinking	.839
Public communication	6%	1.5 (moderate)	(1) creative/journalistic writing, (2) mass communications, (3) creativity	.708
Community engagement	4%	1.7 (moderate)	(1) community relations, (2) advocacy & outreach, (3) leadership	.856

Several of the skills factors are highly correlated, forming two skills areas (Table 19). The cognition factor was highly correlated with the technical research and analysis factor, thus constituting a problem analysis skills competency area. The cognition factor and the other three skill factors—management, community engagement and public communication—were highly correlated with each other to form a problem solutions and applications skills competency area (Table 22).

Table 22. Skills factor correlation matrix

Skills factor	Technical research	Management	Cognition	Public communication	Community engagement
Technical research	1.000	.323	.540	.294	.209
Management		1.000	.494	.534	.454
Cognition			1.000	.509	.417
Public communication				1.000	.544
Community engagement					1.000

Rotation method: Promax with Kaiser normalization

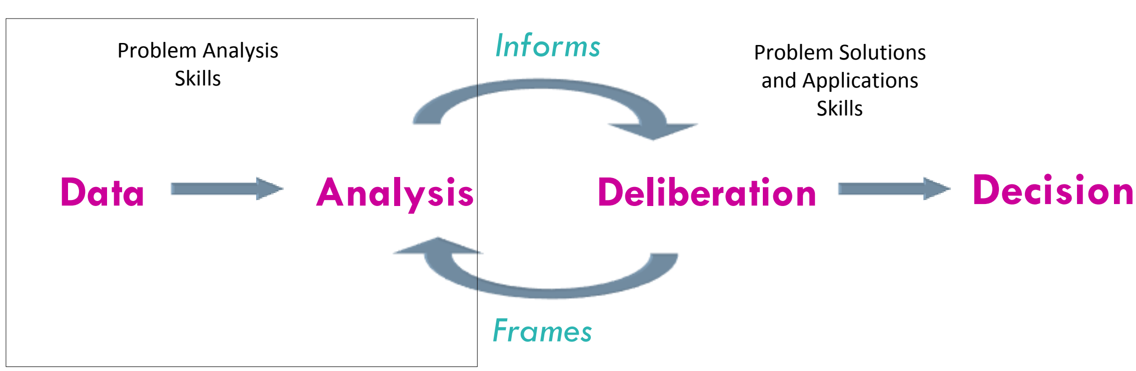
Table 23 lists the three skills competency areas, skills factors and skills variables associated with each factor and its proportional influence on the factor.

Table 23. Skills competency areas

Competency area	Factor	Skills variable (influence/weight)
Problem analysis	Cognition	synthesis (25) problem-solving (23) analysis (19) creativity (17) critical thinking (16)
	Technical research & analysis	field research (26) laboratory research (23) mathematics (15) statistics (13) spatial analysis (11) technical & academic writing (8) oral communication (5)
Problem solutions and applications	Cognition	(same as above)
	Management	personnel management (36) project management (27) leadership (17) decision science (10) information management (10)
	Community engagement	community relations (54) advocacy & outreach (35) leadership (11)
	Public communication	creative & journalistic writing (64) mass communications (28) creativity (10)

The skills factor structure indicates that cognitive skills, with their emphasis on systems thinking and problem solving, are a key element for both the analysis of environmental problems and devising solutions, and that creating solutions for environmental programs requires management skills and societal engagement. Figure 9 illustrates the role of each skill set in a generalized decision-making process. This interpretation of a generalized curriculum structure for skills is supported by the consensus on field identity as focused on interdisciplinary problem solving and decision making which requires both analyzing problems and devising solutions.

Figure 9. Skills factor relationships.



Together, the results of the exploratory factor analysis indicate that an understanding of sustainability and coupled human-nature systems can serve as a foundation for IE programs and three interdisciplinary knowledge areas (natural sciences, coupled human-nature systems management, and development) and two interdisciplinary skill sets (problem analysis and problem solutions and applications) can be used to define a core curriculum.

CHAPTER VII

IDEAL CURRICULUM MODELS FOR

INTERDISCIPLINARY ENVIRONMENTAL PROGRAMS

Research Question

The third research question concerned the number and characteristics of ideal curricular models for IE education.

Methodology

Cluster analysis is a group of statistical techniques used to group or classify objects into groups using a predetermined selection criterion. The resulting clusters will exhibit high internal (within cluster) homogeneity and high external (between-cluster) heterogeneity. It allows the researcher to group cases (in this study, the respondents' ideal knowledge and skill importance ratings for each degree they offer) into similar groups (respondents who rated knowledge and skills similarly).

In cluster analysis, multicollinearity results in a weighting process that affects the analysis; multicollinear variables are implicitly weighted more heavily. Since several of the importance-rated variables exhibited multicollinearity, principal components analysis was used to group similarly rated variables prior to clustering. Reducing the original importance rating variables into sets of knowledge and skill components eliminates multicollinearity while retaining all variables and their variances in the analysis.

The SPSS two-step method was selected as the most appropriate clustering method for this study based on the characteristics of the clustering algorithm and because it provides statistical and graphical outputs that aid in interpretation. Because cluster analysis involves a subjective judgment on an optimal cluster solution, it is important to validate the solution. No consensus method to ensure validity and practical significance has been identified, but several approaches have been proposed. One of the most recommended methods is to cluster analyze separate samples and compare the correspondence of results. We randomly split our sample into two groups and separately analyzed each. Another common method is to use two different clustering algorithms and compare the similarity of the results. This method was also chosen for this study, by analyzing the data using both the SPSS two-step method and Ward's method. A third popular approach is to establish a predictive criterion using variables not included in the analyses but that vary significantly across the clusters. This method was also adopted by using two analytic techniques: descriptive discriminant analysis to test fidelity of cluster membership using the original 39 importance-rated variables (94% correctly classified), and analysis of variance tests to demonstrate significant differences between clusters using variables not included in the cluster analysis. See Appendix I for additional information on the cluster analysis protocol.

Three Ideal Curriculum Models

Cluster analysis conducted on principal component scores derived from program administrators' ratings of the importance of the 16 knowledge and 23 skill variables (for each degree) reveals three ideal curriculum models. These three are closely aligned with the three perspectives on curriculum design discovered in the first phase of the curriculum study (*Environmental Scientist, Environmental Citizen* and *Environmental Problem-Solver)*, reinforcing the existence of three approaches to curriculum design. The three ideal curriculum models emphasize different knowledge and skills areas to prepare graduates for different types of sustainability-oriented scholarship, research and practice. They are labeled *Systems Science*, *Policy and Governance,* and *Adaptive Management*, based upon their educational objectives.

The clusters are characterized by two dimensions that discriminate between the three models, significant differences in mean knowledge and skill factor scores, and by significant differences in degree program features.

Figure 10 illustrates the three model clusters and their relationships based on two dimensions that discriminate between groups. Discriminant analysis was conducted using the factors scores for the ten knowledge and skills factors revealed by maximum likelihood factor analysis as the variables (see Chapter VII). Two functions were revealed, both significant, indicating that the predictors (factor scores) significantly differentiated between the curriculum models.[20]

The first dimension accounts for 64% of the variance, while the second dimension accounts for 36% of the variance between the curriculum model groups. Standardized function coefficients and correlation coefficients revealed that the social sciences and public communication factors are positively associated with the first function while the technical research and natural sciences factors are negatively associated with this function (Table 24). Based on these characteristics of the factors and their associations with the models, this function was labeled *Technical versus Social Focus*. Similarly, the second function was labeled *Problems versus Applications Focus* because of the factors associated with this function and the characteristics of the models.

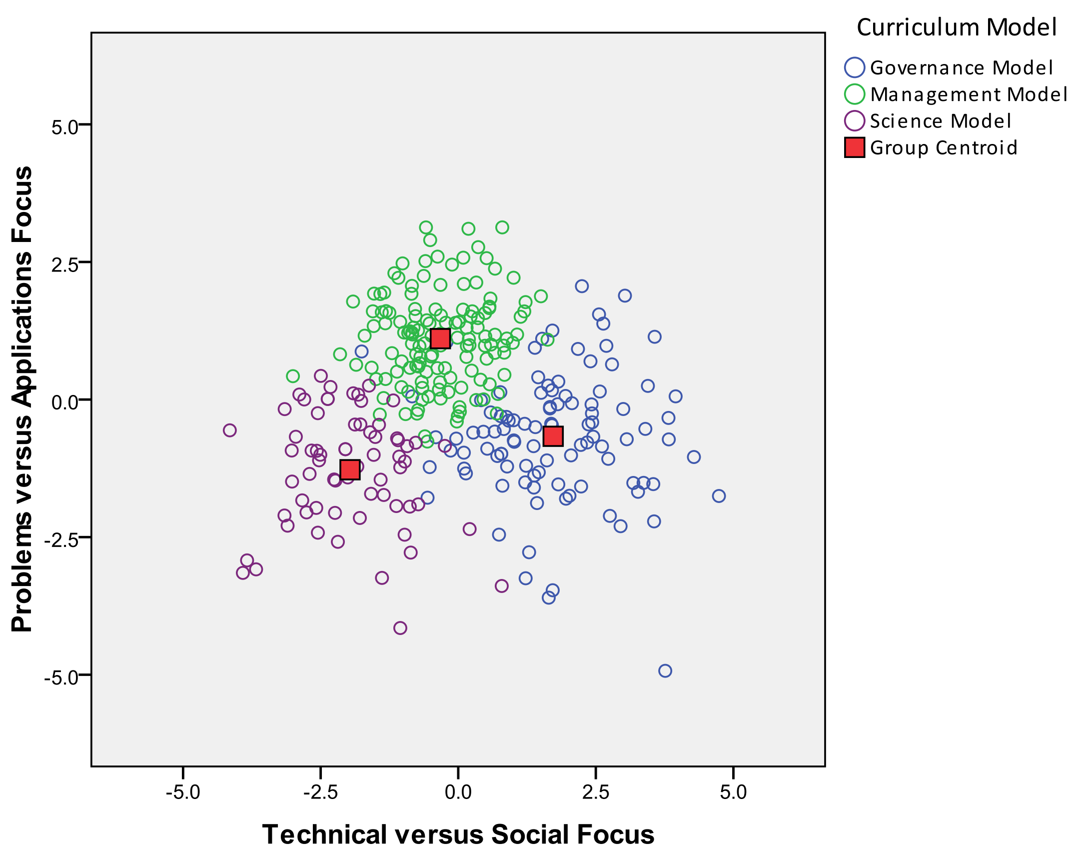
[20] Technical Versus Social Focus function Λ=.167,χ^2(20, n=304)=529.90, p<.001; Problems Versus Applications Focus function Λ=.485,χ^2(9, n=304)=214.82, p<.001.

Table 24. Discriminant analysis correlation coefficients and standardized function coefficients

Knowledge and skills factors	Correlation coefficients with discriminant function T/S Focus	P/A Focus	Standardized function coefficients T/S Focus	P/A Focus
Technical research	-.493*	.337	-.590	.246
Natural sciences	-.452*	.291	-.197	.334
Social sciences	.360*	.311	.628	.267
Public communication	.124*	-.006	.251	-.162
Management	.157	.497*	.201	.507
Community engagement	.255	.360*	.366	.389
Development	.002	.347*	-.017	.390
Natural resources	-.091	.304*	-.197	.334
Humanities	.155	.258*	.212	.310
Cognition	-.050	.195*	-.228	.164

*Largest absolute correlation between each variable and any discriminant function.

Figure 10. Ideal curriculum models plotted on two dimensions



Systems Science Model

The *Systems Science* curriculum model emphasizes knowledge of the natural sciences and technical research and analysis skills centered on laboratory and fieldwork. It has an analytic orientation that emphasizes traditional scientific skills and expertise in the natural sciences. The mean factor scores of this model have the highest mean score for the natural science and technical research and analysis factors and significantly lower mean scores than the other two models for four factors: the social sciences and humanities knowledge factors, and the management and community engagement skills factors (Table 26, Figures 9 and 10).

Figure 11. Mean knowledge factor scores by ideal model type

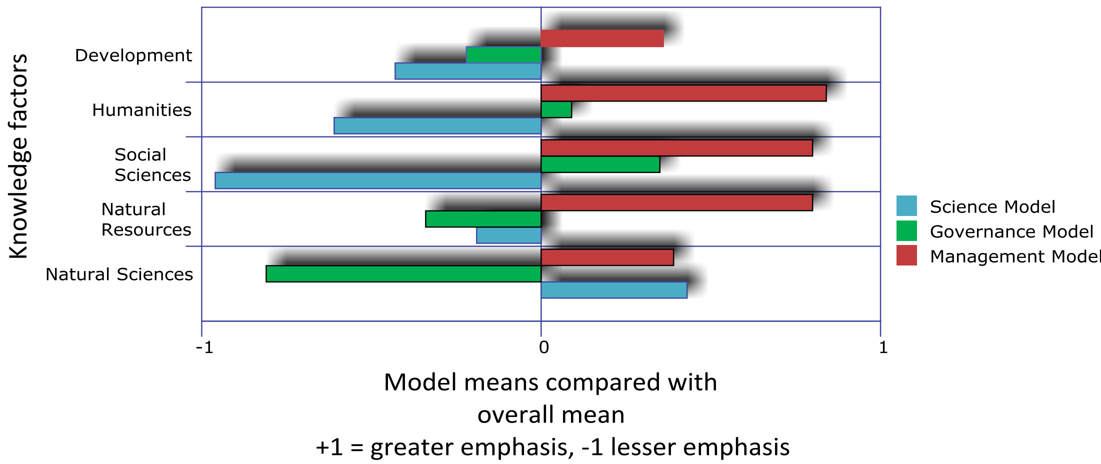
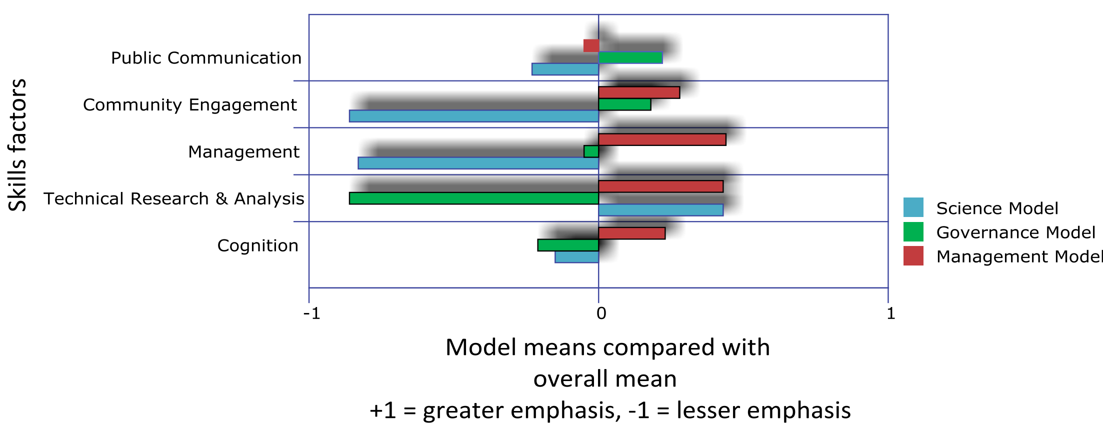


Figure 12. Mean skills factor scores by ideal model type



This model was the least popular of the three models (representing 22% of all degree programs) and was the most unique, exhibiting the most significant differences with the other two models. It is associated with a higher proportion of degree programs with science-focused names—either environmental science(s) or another science (such as marine science)—and with a higher proportion of undergraduate programs (Table 25).

Analysis of variance tests revealed a number of significant differences between the models on degree program requirements, degree program objectives and the inclusion of sustainability in degree program curricula.

Table 25. Degree types by ideal curriculum model

	Ideal Curriculum Model		
Degree label	Science (*n*=66)	Governance (*n*=101)	Management (*n*=137)
Environmental science(s)	64%	19%	45%
Environmental studies	26%	45%	23%
Policy, planning and management	1%	30%	13%
Other science	9%	0%	4%
Other	0%	6%	15%
Degree level			
Baccalaureate	85%	70%	68%
Master's	6%	26%	23%
Doctoral	9%	4%	9%

The undergraduate programs associated with the *Systems Science* model are less likely to require participation in a research project or require an undergraduate thesis or formal research report than those associated with the other two models, and are less likely to share the objectives of preparing students to be environmental leaders and change agents, or improving environmental policy decisions. Graduate programs associated with this model are more likely to require participation in a research project and less likely to require participation in a service learning project. This model is also significantly less likely than the other two models to include sustainability in degree curricula in any of the five ways measured—as a core principle, required coursework, optional coursework, research experiences, or applied/service learning experiences (Tables 26 and 28).

Policy and Governance Model

The *Policy and Governance* curriculum model emphasizes the social sciences, humanities, and public engagement skills. The orientation for this curriculum model is societal and institutional change with a focus on public awareness, policy and governance processes. It includes programs reflecting the *Environmental Citizen* perspective popular in broad liberal arts programs as well as programs designed for the professional preparation of students who plan careers in the environmental policy, advocacy or government arenas. This model places significantly lower importance than the other two models on the natural sciences knowledge and the technical research & analysis skills factors, and higher importance on the public communication skills factor (Table 26, Figures 9 and 10).

This model represents the ideal for 33% of all interdisciplinary degree programs, especially those that are labeled as "environmental studies" or those having an environmental policy or management focus (Table 23). Graduate programs associated with this model are significantly less likely to require a graduate thesis or research project and more likely to require that graduate students participate in a service learning project than the other two models; these results are probably because this model includes the highest proportion of professional master's degree programs. These programs are also more likely to want to prepare undergraduate students to become environmental leaders and change agents, improve environmental policy decisions, and include sustainability in their curricula (in all five ways), although not significantly more so than degree programs associated with the *Adaptive Management* model (Tables 25 and 27).

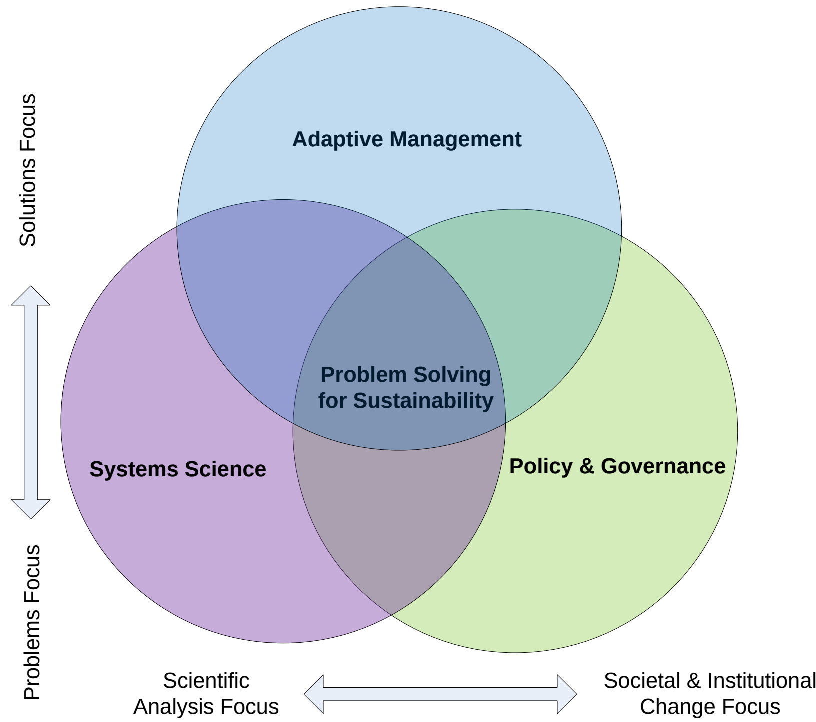
Adaptive Management Model

The *Adaptive Management* curriculum model emphasizes coupled human-nature systems management and both problem analysis and problem solutions and applications skills. The mean factor scores for both the natural resources and development knowledge factors and the management skills factor are significantly higher compared to other two models (Table 27, Figures 9 and 10).

This model is most popular; representing the ideal for 45% of all degree programs, and includes the highest proportion of doctoral and master's of science programs. In addition, program labels are significantly more diverse, including titles such as environmental systems, environmental dynamics, and natural resources (Table 24). Undergraduate degree programs are more likely than the other two models to require participation in a research project and require a thesis or formal research report. They are similar to the *Systems Science* model in the proportion of graduate programs that require participation in a research project. They are similar to the *Policy and Governance* model in their propensity to share the objectives of preparing undergraduate students to become environmental leaders and change agents, improve environmental policy decisions, and include sustainability in their curricula (Tables 26 and 28).

While considerable diversity currently exists among programs, the study has shown that only three ideal approaches to IE education are expressed: *Systems Science, Policy and Governance,* and *Adaptive Management*. These approaches emphasize different knowledge and skill components while sharing a common identity centered on sustainability-oriented research and practice. Figure 11 illustrates how the approaches are related.

Figure 13. Relationships between Ideal Educational Approaches



Two new degree programs and a proposed framework for sustainability science are indicative of the ways in which degree programs may be organized based on these three models. Kajikawa (2008) synthesized information from research papers published in key journals to identify a proposed framework for integrative sustainability-oriented systems science that could serve as a model for programs based on the *Systems Science* model. The new Master's in Development Practice developed by the International Commission on Education for Sustainable Development Practice provides an example of a program focused on societal and institutional change characteristic of the *Policy and Governance* model (International Commission on Education for Sustainable Practice 2008). The recently redesigned five-year environmental science program at ETH Zurich may span all three models depending upon the desired career paths and options chosen by the participating students. Notably, this program analyzed its curricular components to assess how well it prepared graduates for environmental careers and used the results to align the program more closely with professional practice (Hansmann 2009).

Table 26. Significant differences between program objectives, requirement and sustainability inclusion in ideal curriculum models

	Curriculum model		
Program requirements	Science (*n*=66)	Governance (*n*=101)	Management (*n*=137)
Participation in a research project (undergraduate)	11%	26%	37%
Thesis/formal research report (undergraduate)	18%	38%	44%
Participation in a research project (graduate)	89%	37%	71%
Participation in a service learning project (graduate)	0%	23%	5%
Program objectives			
Prepare leaders & change agents (undergraduate)	46%	72%	65%
Improve policy decisions (undergraduate)	30%	65%	61%
Prepare environmental academics (graduate)	90%	30%	43%
Sustainability inclusion			
Core principle (all programs)	9%	41%	33%
Required coursework (all programs)	39%	60%	56%
Optional coursework (all programs)	21%	41%	21%
Research experiences (all programs)	12%	30%	29%
Applied/service learning experiences (all programs)	11%	36%	29%

Table 27. ANOVA test for significant differences of factor score means for ideal curriculum models

Knowledge or skills factor	ANOVA test	Hochberg GT2 post hoc tests (mean difference)
Natural resources	F(2,301)=17.14, p<.001	Management/Science=.545, p<.001 Management/Governance=.690, p<.001
Humanities	*Welsh F(2,301)=16.53, p<001	Science/Governance=-.693, p<.001 Science/Management=-.828, p<.001
Social sciences	*Welsh F(2, 301)=48.33, p<.001	Science/Governance=-1.317, p<.001 Science/Management=-1.155, p<.001
Natural sciences	F(2,301)=71.70, p<.001	Governance/Science=-1.233, p<.001 Governance/Management=-1.194, p<.001

Table 27. ANOVA test for significant differences of factor score means for ideal curriculum models (continued)

Knowledge or skills factor	ANOVA test	Hochberg GT2 post hoc tests (mean difference)
Development	*Welch F(2,301)=20.44, p<.001	Management/Science=.786, p<.001 Management/Governance=.579, p<.001
Technical research & analysis	F(2,301)=87.47, p<.001	Governance/Science=-1.284, p<.001 Governance/Management=-1.288, p<.001
Management	F(2,301)=46.55, p<.001	Science/Governance=-774, p<.001 Science/Management=-1.264, p<.001 Governance/Management=-.490, p<.001
Cognition	F(2,301)=6.78, p<.001	Management/Science=.374, p<.05 Management/Governance=.440, p<.05
Public communication	*Welch F(2,301)=3.81, p<.05	Governance/Science =.449, p<.05
Community engagement	F(2,301)=39.28, p<.001	Science/Governance=-1.040, p<.001 Science/Management=-1.140, p<.001

Robust Welsh statistic and Games Howell post hoc tests reported when the homogeneity of variance assumption is violated. Hochberg GT2 post hoc test reported due to unequal sample sizes; Science *n*=66, Governance *n*=101, Management *n*=137.

Table 28. KWANOVA test for significant differences between programs sharing degree features for ideal curriculum models

Degree program attribute	KWANOVA test	Mann-Whitney post hoc tests
Degree requirements		
Participation in a research project (undergraduate)	H(2)=13.19, p<.001	Management/Science U=1727, z=-3.53, p<.001 Management/Governance U=2613, z=-2.19, p<.05
Thesis/formal research report (undergraduate)	H(2)=9.27, p<.05	Management/Science U=1873, z=-3.08, p<.05
Participation in a research project (graduate)	H(2)=12.67, p<.05	Governance/Science U=64, z=-2.64, p<.05 Governance/Management U=397, z=-3.03, p<.05
Participation in a service learning project (graduate)	H(2)=9.30, p<.05	Science/Governance U=73, z=-2.61, p<.05 Science/Management U=93, z=-3.08, p<.05
Program objectives		
Prepare leaders & change agents (undergraduate)	H(2)=8.99, p<.05	Science/Management U=2146, z=-3.84, p<.05 Science/Governance U=1483, z=-2.90, p<.05
Improve policy decisions (undergraduate)	H(2)=17.53, p<.001	Science/Management U=1835, z=-3.58, p<.001 Science/Governance U=1304, z=-3.84, p<.001
Prepare environmental academics (graduate)	H(2)=10.87, p<.05	Science/Governance U=60, z=-3.26, p<.05 Science/Management U=111, z=-2.66, p<.05
Sustainability inclusion		
Core principle (all programs)	H(2)=19.54, p<.001	Science/Governance U=2283, z=-4.41, p<.001 Science/Management U=3411, z=-3.67, p<.001

Table 28. KWANOVA test for significant differences of proportions of programs sharing degree attributes for ideal curriculum models (continued)

Degree program attribute	KWANOVA test	Mann-Whitney post hoc tests
Required coursework (all programs)	H(2)=7.49, p<.05	Science/Governance U=2633, z=-2.65, p<.05 Science/Management U=3748, z=-2.19, p<.05
Optional coursework(all programs)	H(2)=9.00, p<.05	Science/Governance U=2687, z=-2.60, p<.05 Science/Management U=3559, z=-2.88, p<.05
Research experiences(all programs)	H(2)=7.87, p<.05	Science/Governance U=2747, z=-2.64, p<.05 Science/Management U=3745, z=-2.61, p<.05
Applied/service learning experiences (all programs)	H(2)=12.96, p<.05	Science/Governance U=2499, z=-3.61, p<.001 Science/Management U=3677, z=-2.87, p<.05

CHAPTER VIII

RELATIONSHIPS AND INFLUENCES ON IEPROGRAM CURRICULA

Research Question

The fourth research question asked how administrative and degree program attributes may be related to the ideal curriculum types and what these relationships indicate concerning program structure and evolution.

Methodology

Relationships between ideal curriculum types and program attributes were characterized by analysis of variance tests appropriate for each attribute analyzed (α=.05); either one-way analysis of variance (ANOVA) or Kruskal Wallis analysis of variance by ranks (KWANOVA). Influences were also determined by frequency data and qualitative analysis of the respondents' answers to selected questions.

Relationships between Program Attributes and Ideal Curriculum Models

As discussed in the previous chapter, there are several significant relationships between ideal curriculum models and (1) two degree program requirements (participation in undergraduate or graduate research and the requirement for a thesis or other formal research report); (2) three degree program objectives (preparing students for graduate or professional programs, preparing students to be environmental leaders and change agents, and improving environmental policy decision making); and (3) five ways in which sustainability is included in degree program curricula (core principle, required coursework, optional coursework, research experiences, and service learning/applied experiences).

Two models also differed significantly on enrollment trend. Although most degree programs report positive enrollment trends, those associated with the *Systems Science* model have the highest proportion of degree programs experiencing declining enrollments, while the *Adaptive Management* model has the highest proportion of degree programs with growing enrollments. In the *Policy and Governance* model, the proportion of programs experiencing growing enrollments fell between the other two models and was not significantly different from either (Table 29).

Table 29. Ideal curriculum models and enrollment trends

Ideal curriculum model	Enrollment trend Rapid growth (*n*=63)	Growth (*n*=113)	Steady (*n*=88)	Decline (*n*=37)
Science	16%	32%	35%	17%
Governance	19%	40%	31%	10%
Management	24%	39%	25%	12%

Mann-Whitney test (non-parametric *t*-test) Science/Management U=3768, z=-1.94, p<.05

A possible explanation is suggested by the degree program attributes positively associated with program growth—four of the five sustainability inclusion methods and four program objectives. Of the five sustainability inclusion methods, only required coursework was not positively associated with program growth trends (see Chapter IV, Tables 10 and 11). The three program objectives positively associated with undergraduate program growth are: (1) preparing students to be environmental leaders and change agents, (2) advancing environmental research, and (3) providing community service. The program objective of improving environmental policy decisions is positively associated with graduate program growth. These relationships suggest why more programs in the *Systems Science* model are declining since this model, in contrast with the other two models, was significantly less likely to include sustainability or share two of these four program objectives—preparing students to be environmental leaders and change agents, and improving environmental policy decisions (see chapter VII, Tables 265 and 28). Students are expressing increasing interest in environmental issues and sustainability. The most recent *Princeton Review* (2009) survey reveals that 66% of incoming students report that they include an institution's commitment to environmental issues (including academic offerings) in their assessment of which college to attend.

Influence of Administrative Program Features

Several administrative program attributes potentially may exert important influences on curriculum structure. These include: (1) the Carnegie class of the host institution, demonstrated to influence program administrators' perspectives on curriculum design in the first phase of this study (Vincent and Focht, 2009), (2) the program's host institution's census region (due to economic and sociopolitical differences), (3) the program's administrative location within the administrative hierarchy (which may influence faculty participation, autonomy, resource allocation, and other attributes), and (4) the program administrator's educational preparation (which may influence design of the curriculum).

Only one of these attributes, program administrators' educational preparation, proved to distinguish between ideal curriculum models. Degree programs associated with the *Systems* S*cience* model have the least diversity in program administrators' educational preparation and the highest proportion of program administrators whose educational preparation is exclusively in the natural sciences. Although the majority of the administrators associated with all three models hold degrees exclusively in the natural sciences, the programs associated with the other two models exhibit more diversity in administrators' educational preparation. The *Policy and*

Governance model has the highest proportion of administrators with degrees in the social sciences and humanities, and the *Adaptive Management* model the highest proportion of those with interdisciplinary degrees (Table 30).

Table 30. Program administrator educational preparation and ideal curriculum models

Educational preparation category	Ideal curriculum model Science (*n*=66)	Governance (*n*=101)	Management (*n*=137)
Natural sciences	68%	48%	52%
Applied sciences or professional	12%	22%	20%
Social sciences or humanities	9%	16%	6%
Interdisciplinary	11%	14%	22%

Mann Whitney tests (non-parametric *t*-test) Science/Governance U=1947, z=-2.13, p<.05; Science/Management U=2742, z=-2.02, p<.05.

The lower diversity of program administrators' educational preparation in the *Systems Science* model is due partly to a higher proportion of these degree programs located within natural science departments.[21] However, the differences are also due to dissimilarity in the way program administrators with different educational backgrounds rated the importance of the knowledge and skill factors (Table 31). Three knowledge factors (natural sciences, natural resources, and development) and one skills factor (management) exhibit significant differences in mean scores based on administrators' educational preparation. Administrators were grouped into one of four categories based upon their degrees earned: natural sciences, applied/professional fields, social sciences/humanities, and interdisciplinary. Administrators with interdisciplinary or applied/professional degrees rated the importance of natural resources, development knowledge, and management skills higher than those whose educational preparation was in the natural sciences or in the social sciences/humanities. Those with degrees in the natural sciences rated the importance of the natural sciences higher than the other groups, and those with degrees in the social sciences/humanities placed significantly lower importance on development knowledge and management skills.

Table 31. ANOVA test for significant differences of factor score means for administrator educational preparation categories

Knowledge or skills factor	ANOVA test	Games-Howell post hoc tests (mean difference)
Natural resources	Welsh F(3,259)=6.76, p<.001	Interdisciplinary/Natural sciences=.586, p<.001 Interdisciplinary/Social sciences & humanities=.706, p<.05
Natural sciences	Welsh F(3,259)=3.86, p<.05	Interdisciplinary/Natural Science=-.438, p<.05
Development	Welsh F(3,259)=12.86, p<.001	Social sciences & humanities/Natural sciences=-.618, p<.05 Social sciences & humanities/Applied sciences & professional=-1.30, p<.001

[21] 43% for science programs versus 27% for governance programs and 28% for management programs.

		Social sciences & humanities/Interdisciplinary=-.800, p<.05

Table 31. ANOVA test for significant differences of factor score means for administrator educational preparation categories (continued)

Knowledge or skills factor	ANOVA test	Games-Howell post hoc tests (mean difference)
Management	Welsh F(3,256)=4.80, p<.05	Applied sciences & professional/Natural sciences=.536, p<.05 Applied sciences & professional/Social sciences and humanities=-.719, p<.05

Robust Welsh statistic and Games Howell post hoc tests reported when the homogeneity of variance assumption is violated.

Although programs' administrative location does not influence the ideal curriculum models, our analysis provides evidence that programs housed within their own environmental academic units may have important advantages when compared to program located within other departments or academic units. The survey reveals significant differences in program administrators' levels of satisfaction with a number of factors that influence program success, and differences in the ability of programs to offer an ideal interdisciplinary curriculum depending upon a program's administrative location.

The survey asked program administrators to gauge the importance of various factors on the success of IE programs in general and the level of their satisfaction with how well their own program addressed or utilized each factor in its own success. The survey included five groups of influencing factors: curriculum, institutional, graduate employment, external support, and partnership (Table 32).

The factors rated of mean high importance for program success included curriculum (incorporating real world problems into courses, developing courses) and institutional factors (leadership, faculty support). Factors rated of moderate importance included curriculum (defining degrees and specializations, course sequencing), institutional (location within the administrative hierarchy, institutional support, competition with other academic units) and student employment factors (local and/or regional employment, national employment). External support and partnership factors were all rated of mean low importance for program success.

Levels of satisfaction with various factors that influence program success are generally higher for programs within their own IE administrative units. Over half of the programs located within their own academic units are highly satisfied with their administrative location in contrast to less than a third of programs in other departments or that cross other academic units. Programs located in their own IE academic unit are significantly more likely to be highly satisfied with their ability to offer relevant degrees and specializations, provide effective program leadership, prepare students for employment, compete for funding and public support, and participate in partnerships with other educational institutions and organizations (Tables 32 and 33).

Table 32. Effect of program location on high satisfaction with factors that influence program success

Influencing factor	Environmental department (*n*=50)	Within other department(s) (*n*=88)	Environmental college, institute or other primary academic unit (*n*=32)	Within or across other academic unit(s) (*n*=76)
		Curriculum factors		
Offer relevant degrees & specializations	63%	41%	52%	40%
Develop courses	54%	42%	35%	35%
Appropriately sequence courses	33%	34%	32%	32%
Incorporate real world problems	71%	72%	65%	72%
		Institutional factors		
Institutional support	29%	16%	22%	20%
Program location	55%	27%	59%	32%
Program leadership	72%	44%	66%	62%
Faculty support	54%	38%	53%	53%
Compete with other academic units	22%	8%	34%	23%
		Graduate employment factors		
Prepare graduates for local/regional employment	49%	49%	65%	38%
Prepare graduate for national employment	38%	21%	45%	19%

Table 32. Effect of program location on high satisfaction with factors that influence program success (continued)

Influencing factor	Environmental department (*n*=50)	Within other department(s) (*n*=88)	Environmental college, institute or other primary academic unit (*n*=32)	Within or across other academic unit(s) (*n*=76)
External support factors				
Compete for federal funding	16%	8%	31%	11%
Compete for state and local funding	14%	7%	6%	4%
Compete for foundation & private finding	27%	9%	22%	11%
Win public support	12%	2%	22%	11%
Win political support	9%	1%	9%	6%
Partnership factors				
Participate in educational institution partnerships	24%	11%	22%	16%
Participate in governmental agency partnerships	27%	15%	20%	18%
Participate in private sector partnerships	21%	17%	10%	11%
Participate in NGO partnerships	25%	7%	25%	14%
Participate in professional society partnerships	11%	4%	10%	4%

Table 33. KWANOVA test for significant differences between programs with high satisfaction on factors that influence program success.

Influencing factor	KWANOVA test
Curriculum factors	
Offer relevant degrees and specializations	H(4)=12.11, p<.05
Develop courses	H(4)=9.66, p<.05
Institutional factors	
Program location	H(4)=20.07, p<.001
Program leadership	H(4)=13.49, p<.05
Compete with other academic units	H(4)=14.85, p<.05
Graduate employment factors	
Prepare students for national employment	H(4)=9.40, p<.05
External support factors	
Compete for federal funding	H(4)=14.30, p<.05
Compete for foundation and private funding	H(4)=25.06, p<.001
Win public support	H(4)=17.49, p<.05
Partnership factors	
Participate in U.S. higher education institution partnerships	H(4)=17.21, p<.05
Participate in foreign higher education partnerships	H(4)=13.21, p<.05
Participate in governmental agency partnerships	H(4)=13.24, p<.05
Participate in non-governmental organization partnerships	H(4)=15.55, p<.05
Participate in professional society partnerships	H(4)=15.28, p<.05

Programs located in their own environmental departments, colleges, or cross-institutional centers or programs are also more likely to provide an ideal curriculum. The survey asked program administrators to rate the importance of 39 knowledge and skills areas in an ideal curriculum for each degree their program offers and then to rate the actual emphases in their current curricula. IE degree programs located within their own environmental school, college or division are most likely to provide curricula with ideal levels of emphases on knowledge and skills areas, meeting or exceeding the ideal mean emphases in all but three skills areas—community relations, synthesis and analysis (Table 34). In contrast, programs located within other departments were clearly at a disadvantage, meeting the ideal emphases for only 11 of the 39 areas.

Table 34 Effect of program location on the ability to provide ideal emphases on knowledge and skills areas in IE degree program curricula

Knowledge or skills area	Mean ideal emphasis	Environmental department (*n*=50)	Other department(s) (*n*=88)	Environmental school, college or division (*n*=7)	Other school, college, or division (*n*=76)	Environmental center, institute, consortium (*n*=25)
		Mean curriculum emphases				
Natural sciences knowledge						
Physical sciences	2.5	2.1	2.4	2.5	2.3	2.3
Life sciences	2.5	2.3	2.4	2.5	2.4	2.3
Social sciences knowledge						
Policy, planning & administration	2.3	2.2	1.7	2.3	2.1	2.2
Economics	1.8	2.5	1.4	2.2	2.0	1.9
Other social sciences	1.7	2.2	1.4	1.9	2.0	1.6
Humanities knowledge						
History	1.3	1.7	1.3	1.5	1.3	1.2
Philosophy & ethics	1.8	2.3	1.6	1.8	1.8	1.7
Literature & language arts	1.2	1.6	1.2	1.9	1.2	1.1
Applied sciences & professional knowledge						
Engineering & built environment	1.2	1.6	1.0	1.6	1.2	1.5
Business	1.4	1.7	1.0	1.7	1.4	1.3
Education	1.1	1.7	0.9	1.3	1.3	1.2
Research methods	2.3	2.5	2.2	2.6	2.4	2.2
Interdisciplinary knowledge						
Ecology	2.6	2.6	2.5	2.6	2.6	2.5
Geography	1.9	2.1	1.6	2.0	2.0	1.8
Natural resources management & agriculture	2.0	2.5	1.7	2.3	1.8	2.2
Sustainability	2.2	2.3	1.8	2.1	2.2	2.2
Knowledge area emphases met/exceeded (within 0.1)		14/16	6/16	16/16	13/16	14/16
Cognitive skills						
Critical thinking	2.7	2.5	2.4	2.7	2.6	2.8
Problem solving	2.8	2.6	2.4	2.8	2.7	2.8
Creativity	2.3	2.4	1.8	2.7	2.2	2.5
Synthesis	2.6	2.4	2.1	2.4	2.4	2.5
Analysis	2.4	2.2	2.0	2.2	2.3	2.4

Table 34 Effect of program location on the ability to provide ideal emphases on knowledge and skills areas in IE degree program curricula (continued)

Knowledge or skills area	Mean ideal emphasis	Environmental department (*n*=50)	Other department(s) (*n*=88)	Environmental school, college or division (*n*=7)	Other school, college, or division (*n*=76)	Environmental center, institute, consortium (*n*=25)
		Mean curriculum emphases				
Communication skills						
Technical & academic writing	2.7	2.5	2.4	2.7	2.5	2.4
Creative & journalistic writing	1.4	1.7	1.2	1.6	1.5	1.3
Oral communication	2.6	2.4	2.3	2.6	2.3	2.4
Mass communication	1.5	1.5	1.2	1.6	1.6	1.4
Research skills						
Literature research	2.2	2.3	2.0	2.3	2.1	2.1
Field research	2.4	2.6	2.4	2.8	2.4	2.8
Laboratory research	2.2	2.4	2.2	2.5	2.3	2.8
Social research	1.9	2.2	1.6	2.4	2.0	2.1
Computational skills						
Mathematics	2.1	2.1	2.0	2.6	2.0	2.4
Statistics	2.4	2.5	2.2	2.9	2.2	2.5
Spatial analysis	2.2	2.6	2.0	2.2	2.4	2.3
Decision sciences	1.6	1.6	1.2	1.8	1.6	1.6
Information management	1.6	1.9	1.3	1.7	1.8	1.4
Managerial skills						
Personnel management	1.1	1.0	0.7	1.3	1.2	1.3
Project management	1.3	1.3	0.9	2.0	1.4	1.5
Leadership	1.7	1.7	1.2	2.7	1.8	1.5
Community relations	1.8	1.7	1.3	1.3	1.8	1.7
Advocacy & outreach	1.6	1.6	1.3	1.7	1.8	1.6
Skills area emphases met/exceeded (within 0.1)		17/23	3/23	20/23	20/23	19/23
Total knowledge and skills area emphases met/exceeded (within 0.1)		31/39	9/39	36/39	33/39	33/39

Given the wide diversity of institutional types and structural reform initiatives designed to promote interdisciplinary learning and research, the optimal location for an individual IE program may depend on the program and its host institution. However, evidence from the survey indicates that programs within their own IE department, school, college or cross-institutional academic unit may have important advantages over programs that exist within other departments.

An independent environmental (or sustainability) school, college or cross-institutional center or institute can serve many needs within an educational institution, as well as providing the capacity to cope with burgeoning student interest in environmental issues and sustainability and employer demand for professionals with sustainability training appropriate to their field. A broad administrative structure can more easily provide general education classes dealing with environmental issues and sustainability, offer environmental and sustainability minors and dual majors for students in traditional disciplinary programs, and support its own IE majors. A highly visible and integrated undergraduate and graduate program facilitates recruitment and retention of students and enhances undergraduate education.

An environmental school or college can support an explicitly interdisciplinary research and educational community, while also drawing upon core disciplinary strengths throughout the university. Importantly, it affords a tenure-track home for interdisciplinary faculty—an essential consideration for promoting interdisciplinary scholarship and research (Pfirman et al. 2005). It can also facilitate and support collaborative interdisciplinary research by providing a stable forum for developing and implementing joint projects and campus sustainability initiatives, thereby increasing the competitiveness of the university and its faculty in winning funding for environmental and sustainability research and in attracting students. Finally, an interdisciplinary college or equivalent can connect the university to society by creating a powerful, visible organization dedicated to solving pressing societal problems (González, Neimeier & Navrotsky 2003).

A trend appears to be emerging where more programs are transitioning or merging into their own academic units and hiring their own faculty. A number of programs (7%) participating in the survey reported that they are moving into new administrative structures and/or hiring their own core or jointly-appointed faculty: three in new departments, two in new institutes, two in new schools, and five as mergers with other departments to form new renamed, repurposed departments. Several others reported new institutional arrangements allowing them to hire core faculty or share faculty with other departments. Two of the more dramatic changes reported in the media include the creation of the new School of Sustainability at Arizona State University (Blanchet 2008) and the formation of a new College of the Environment at the University of Washington—purported to be the largest environmental college in the world.

These changes are due to the increasing recognition of the importance of IE programs in sustainability-oriented problem solving centered on an understanding and management of complex coupled human-nature systems. These developments and the rapid growth in the field add to the impetus to define core principles for IE programs that can guide curriculum design.

CHAPTER IX

CONCLUSIONS AND IMPLICATIONS

Building Workforce Capacity

Two current trends influence the evolving roles for the graduates of IE programs and indicate how the three ideal curriculum models for IE higher education may prepare students for emerging environmental careers.

The first is that the need for the participation of most, if not all, fields of inquiry in solving complex and interrelated global environmental problems. Jane Lubchenco (1998, 491), writing on behalf of the board of the American Association for the Advancement of Science, eloquently challenged all scientists to rethink the way science is deployed to meet the challenges of the future.

> The concept of what constitutes "the environment" is changing rapidly. Urgent and unprecedented environmental and social changes challenge scientists to define a new social contract….The new and unmet needs of society include more comprehensive understanding and technologies for society to move toward a more sustainable biosphere—one which is ecologically sound, economically feasible and socially just.

In response, the federal government, institutions of higher education, non-profit and for-profit organizations, and thousands of individual scientists have realigned research priorities, instituted new funding programs, and designed new interdisciplinary structures to facilitate interdisciplinary human-nature systems research, assist in the development of new sustainability policies, and support action aimed at solving pressing environmental problems. The national *Sustainability Research Strategy* (U.S. Environmental Protection Agency 2007) and the strategies recommended by the National Science Foundation's Advisory Council for Environmental Research and Education (National Science Foundation AC-ERE 2009) illustrate how the federal government is working to engage many disciplines and entities in working toward enhanced understanding of complex environmental systems, promoting a higher level of public environmental literacy, and providing a foundation for informing policy decisions.

The second trend is the increasing importance placed on new modes of research, knowledge production and education that transcend disciplinary boundaries and address scientific and societal problems using systems thinking and analysis (Hirsch Hadorn et al. 2008; Frodeman et al. 2009). The *Sustainability Research Strategy* highlights the importance of these new sustainability-oriented, systems-based approaches:

> "The focus on sustainability research recognizes the changing nature of environmental challenges that society faces today…the Agency must provide information to help address a broader set of environmental issues involving population and economic growth, energy use, agriculture, and industrial development. Capably addressing these questions, and the tradeoffs they entail, requires the new system-based focus on science and analysis" (U.S. Environmental Protection Agency 2007, 1).

The literature discussing the theories, mechanisms, methods, and challenges of these new integrative modes of inquiry and decision making is vast and growing. There is substantial terminological ambiguity concerning the various terms describing interdisciplinary processes, as well as considerable diversity in how these new processes are structured, implemented, and evaluated (Balsiger 2004; van Kerkhoff 2005; Lengwiler 2006; Barry, Born, and Wezkalnys 2008; Jacobs & Frickel 2009).

Two forms of knowledge production and decision-making processes are most often referred to as either interdisciplinary or transdisciplinary processes. The most frequently cited distinctions between these two forms are based on the actors included in the process and the primary purpose of the process. Interdisciplinary processes are most often described as those undertaken by academics and other scientific and technological experts to gain understanding of complex environmental systems and phenomena. Transdisciplinary processes include other types of actors in addition to scientific and technological experts, including environmental practitioners, policymakers, economic sector representatives, and public stakeholders. These processes are explicitly designed to solve societal problems, linking the results directly to policy and management decisions (Fiksel 2006; Bosch et al. 2007; Pohl 2008; Wiek and Walter 2009). Knowledge integration and mutual learning are key goals for both interdisciplinary and transdisciplinary processes, explicitly acknowledging and incorporating different value rationalities and forms of knowledge relevant to the problem or issue under consideration (Godemann 2008; Polk and Knutsson 2008).

Linking science, policy and management is an important component of these new interdisciplinary and transdisciplinary processes (van Kerkhoff 2005; Runhaar, Dieperink and Driessen 2006; Pohl 2008). Several authors have identified linking policy and science as "one of the critical unmet needs of society" and point to the need for "translators" trained to work at the policy-science and management-science interfaces to help bridge science and policy (Lubchenco 1998; Clark 2002; Runhaar, Driessen and Vermeulen, 2005; Holmes and Clark 2008; Pohl 2008).

Environmental professionals point to the relevance of sustainability-oriented integrative processes in their work, particularly the need for professional skills related to context-specific problem solving that engages a variety of public and private entities (Jørgensen and Lauridsen

2005; Martin, Brannigan and Hall 2005; Newman 2005; Runhaar, Driessen and Vermeulen 2005). They emphasize that professional competence is linked to problem solving in specific contexts—"working with environmental issues in the interplay of companies, consultants, regulatory authorities, local communities and non-governmental organizations" (Jørgensen and Lauridsen 2005:49). They conclude that environmental professionals' education should be structured "more along thematic guidelines that provide students with a set of problem-solving strategies, and integrate general management principles and organizational theory" (Jørgensen and Lauridsen 2005:49).

A group of graduate students in the Biogeochemistry and Environmental Biocomplexity program at Cornell University conclude that a conventional emphasis on disciplinary research and intellectual independence in graduate school leaves them ill-prepared for employment in the "fast-paced, solution-oriented world of environmental management" (Moslemi et al. 2009:514). These students recommend a more integrative approach to training that explicitly transcends disciplinary boundaries, fosters teamwork and encourages student initiative.

Finally, a recent analysis by Brand and Karvonen (2007) argues that an "ecosystem of expertise" is needed to effectively develop, implement, and manage sustainability projects. This expertise should include: (1) an "outreach expert who communicates effectively to non-experts," (2) an "interdisciplinary expert who understands the overlaps of neighboring disciplines," (3) a "meta-expert who brokers the multiple claims of relevance between different forms of expertise," and (4) a "civic expert who engages in democratic discourse with experts and non-experts" (p. 21). These forms of expertise align well with the three IE programs' approaches to curriculum design: *Science* (interdisciplinary expert), *Governance* (outreach expert and civic expert), and *Management* (meta-expert).

These trends suggest that students prepared within ideal IE programs are uniquely qualified to participate in new integrative and systems-based research, knowledge production, and decision making processes.

The *Systems Science* model can prepare scientists who, through their combination of breadth of understanding of sustainability and interdisciplinary processes, as well as disciplinary depth in an area of the natural sciences or thematic areas such as biodiversity, can effectively participate in interdisciplinary research to inform knowledge production and decision-making processes.

The *Policy and Governance* model can prepare policy and administration professionals to serve as critical policy actors within transdisciplinary processes as well as translators working at the policy-science and policy-management interfaces.

Professionals prepared in programs embracing the *Adaptive Management* model can serve as the "meta-experts" and decision process managers who understand the relevance of various expertise and knowledge claims in interdisciplinary and transdisciplinary processes and therefore can construct, facilitate, and manage these processes.

Conclusions, Limitations and Next Steps

The findings from this study provide a broad framework for understanding IE higher education programs and guiding curriculum design. They indicate that an understanding of sustainability and coupled human-nature systems can serve as a foundation and three interdisciplinary knowledge areas (natural sciences, coupled human-nature systems management, and development) and two interdisciplinary skill sets (problem analysis and problem solutions and applications) can be used to define a core curriculum.

While considerable diversity currently exists among programs, this study has shown that only three ideal approaches to IE education are expressed: *Systems Science, Policy and Governance,* and *Adaptive Management*. These approaches emphasize different knowledge and skill components while sharing a common identity centered on sustainability-oriented systems-based research and practice. The graduates of IE programs based on these models can fulfill current and emerging roles as participants, guides, facilitators and managers within collaborative, integrative environmental research, policy-making and management processes.

The study provides a foundational reference point for future discussions on core competencies. Consensus on field identity seems imminent. Legitimation of three approaches to curricular design is likely. The importance of interdisciplinary pedagogy is nearly universal. These are the foundational elements that will frame future research.

The findings have already been widely used by many institutions for strategic planning, updates of existing programs and development of new programs. The National Council for Science and the Environment will offer consulting services to program directors based upon the results. The Interdisciplinary Environmental Association is conducting a series of roundtable discussions that are informed by the study. The Association of Environmental Studies and Sciences has invited panel discussions on the findings at its 2010 meeting. A significant proportion of the members of the Council of Environmental Deans and Directors attending the January, 2010 CEDD Business Meeting indicated they believe the findings provide a foundation for moving forward now on developing degree certification criteria or accreditation standards. Finally, the Council of Environmental Deans and Directors will discuss how the study may frame currently planned investigations into core competency guidelines for other related areas of environmental education, including energy, health, and agriculture.

In spite of the current applicability of the study for IE programs and discussion on core competencies, it has several important limitations. Much more remains to be learned before core competency recommendations can be formulated that can gain broad acceptance. The specific knowledge and skill elements included within each curriculum competency area have not been determined. While many elements could apply to all programs, others will vary based on specific program themes related to topic (e.g., biodiversity, watersheds, climate change), economic sector (e.g., energy, architecture, agriculture), or region (e.g., coastal, arid, alpine). Extensive dialogue is needed to explore the possibility for consensus on curricular content, pedagogy, and administration and on whether such prescriptions should vary across the three ideal curriculum models.

The study is descriptive, describing the current state of IE education, not prescriptive, describing how IE education should evolve to meet future workforce and societal needs. Tying these findings to the results of studies investigating the relationship between educational preparation and the career trajectories of program graduates, such as the CEDD Campus to Careers study, will provide important insights into how well programs are preparing students for evolving IE careers.

Notably, the relationship between interdisciplinary environmental programs and new emerging programs in sustainability science and studies is unclear. Are interdisciplinary environmental studies and sciences and sustainability studies and sciences two different species of inquiry that are moving apart from one other furthering the distinction of each as separate and mutually exclusive topics of inquiry? Are they hybridizing in such a manner that they will someday become a single interdisciplinary field? Or are they two different fields of inquiry that are neither converging nor diverging, but rather evolving in parallel trajectories with similar content where only the names of the programs are different? Studies to investigate the relationships between IE programs and sustainability programs are needed to determine which of these scenarios is most accurate.

A potential third phase of the CEDD curriculum study includes two investigations: the first on model programs and the second on curriculum convergence. In the model program investigation, we will utilize information from the survey to identify successful programs that best represent the three ideal curriculum models and conduct an in-depth study of curriculum elements and structure. This will allow us to explore ways that these model programs meet the challenges of interdisciplinary and sustainability solution-oriented education for each ideal curriculum type across programs with varying attributes. The curriculum convergence investigation will look at changes in curriculum design and program administration among programs established before 1985 to determine whether curricula are converging on one or more models, are diverging, or are trending in no particular direction.

The results of this study and future studies will facilitate and inform a national dialogue on core competence areas that can form the basis of a consensus on curriculum design and guidelines for program certification and/or accreditation standards for IE programs.

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APPENDICES

APPENDIX A - LIST OF PARTICIPATING INSTITUTIONS/PROGRAMS

(n=264 institutions, 286 programs)

*Institutions/programs participating in both phases, ** institutions/programs participating in phase I only

Institution	State	Program name
Abilene Christian University	TX	Environmental Science Program
*Adelphi University	NY	Environmental Studies Program
*Alabama A&M University	AL	Environmental Science Program
Albright College	PA	Environmental Science and Studies Program
Alderson-Broaddus College	WV	Environmental Science Program
Alfred University	NY	Environmental Studies Program
*Allegheny College	PA	Department of Environmental Science
Anna Maria College	MA	Environmental Science Program
*Antioch University - New England	NH	Department of Environmental Studies
Aquinas College	MI	Environmental Science Program
Arkansas State University	AR	Environmental Science Graduate Program
Austin College	TX	Center for Environmental Studies
**Ball State University	IN	Department of Natural Resources & Environmental Management
**Bard College	NY	Environmental Policy Program
Barnard College	NY	Environmental Science Program
Bates College	ME	Environmental Studies Program
*Baylor University	TX	Department of Environmental Studies
Beloit College	WA	Environmental Studies Program
**Benedict College	SC	Environmental Health Science Program
Benedictine University	IL	Environmental Science Program
Bethany College	WV	Environmental Science Program
Boise State University	ID	Master of Public Administration-Natural Resources and Environmental Policy and Administration Program
**Bowdoin College	ME	Environmental Studies Program
Bowling Green State University	OH	Department of the Environment and Sustainability
Briar Cliff University	IA	Environmental Science Program
Brigham Young University	UT	Environmental Science Program
Bucknell University	PA	Environmental Studies Program
California Polytechnic State University - San Luis Obispo	CA	Forestry and Natural Resources and Environmental Management and Protection Programs
California State University - Channel Islands	CA	Environmental Science and Resource Management Program
California State University - East Bay	CA	Environmental Science Program

California State University - Long Beach	CA	Environmental Science and Policy Program
California State University - Monterey Bay	CA	Environmental Science, Technology and Policy Program
California State University - Sacramento	CA	Environmental Studies Program
California State University - San Bernardino	CA	Environmental Science Masters Program
Canisius College	NY	Environmental Science Program
Carroll College	WI	Environmental Science Program
Castleton State College	VT	Environmental Science Program
**Catholic University of America	DC	Environmental Studies Program
Clark University	MA	Environmental Science and Policy Graduate Program, Department of International Development, Community and Environment
*Clemson University	SC	Environmental and Natural Resource Program
Cleveland State University	OH	Environmental Science Program
Cleveland State University	OH	Environmental Studies Program
Colby College	ME	Environmental Studies Program
Colby-Sawyer College	NH	Department of Environmental Studies
**Colgate University	NY	Environmental Studies Program
College of Charleston	SC	Environmental Studies Masters Program
College of Saint Benedict/Saint John's University	MN	Environmental Studies Department
College of the Atlantic	ME	Graduate Program in Human Ecology
College of William and Mary	VA	Environmental Science and Policy Program
Colleges of the Fenway Consortium	MA	Joint Environmental Sciences Program
Colorado College	CO	Environmental Science Program
Columbia College	MO	Environmental Studies Program
Columbia University	NY	Master of Public Administration-Environmental Science and Policy Program
Concordia University at Austin	TX	Environmental Science Program
Cornell University	NY	Natural Resources Program
Cornell University	NY	Biology and Society Program
Cornell University	NY	Science of Natural and Environmental Systems Program
CUNY (City University of New York) Brooklyn College	NY	Environmental Studies Program
CUNY Hunter College	NY	Environmental Studies Program
Davis & Elkins College	WV	Environmental Science Program
Delaware State University	DE	Environmental Science Program
Doane College	NE	Environmental Science Program
Duke University	NC	Environmental Sciences and Policy Program
*Duquesne University	PA	Environmental Science, Management and Policy Programs
Eckerd College	FL	Environmental Studies Program
Elizabethtown College	PA	Environmental Science Program

Elmira College	NY	Environmental Studies Program
Evergreen State College	WA	Environmental Studies Program
Evergreen State College	WA	Graduate Program on the Environment
Ferrum College	VA	Environmental Science Program
*Florida Agricultural and Mechanical University	FL	Environmental Sciences Undergraduate Program
*Florida Agricultural and Mechanical University	FL	Environmental Sciences Graduate Program
**Florida Atlantic University	FL	Environmental Sciences Program
Florida Gulf Coast University	FL	Environmental Sciences Graduate Program
Florida Southern College	FL	Biology-Environmental Studies Program
Franklin Pierce University	NH	Environmental Science and Studies Programs
Fresno Pacific University	CA	Environmental Science and Studies Program
**Frostburg State University	MD	Environmental Analysis and Planning Program
Green Mountain College	VT	Natural Resources Management Program
Green Mountain College	VT	Environmental Studies Masters Program (Online)
Guilford College	NC	Environmental Studies Program
Gustavus Adolphus College	MN	Environmental Studies Program
Hamilton College	NY	Environmental Studies Program
Hampton University	VA	Marine and Environmental Science Program
Hardin-Simmons University	TX	Environmental Science Program; Environmental Management Graduate Program
**Hendrix College	AR	Environmental Studies Program
**Howard University	DC	Environmental Studies Program
*Humboldt State University	CA	Environmental Science & Natural Resources Planning & Interpretation Programs
Illinois Institute of Technology	IL	Environmental Management Program
Indiana University - Bloomington	IN	Environmental Science Graduate Program
*Indiana University-Northwest	IN	School of Public and Environmental Affairs
**Inter-American University of Puerto Rico	PR	Environmental Science Program
*Iowa State University	IA	Biorenewable Resources and Technology Interdepartmental Graduate Program
Ithaca College	NY	Environmental Studies Program
**Kentucky State University	KY	Agricultural and Environmental Science Program
Kings College	PA	Environmental Program in Biology
Lambuth University	TN	Environmental Science and Environmental Studies Program
Lehigh University	PA	Environmental Initiative
*Lewis & Clark College	OR	Environmental Studies Program
Lewis University	IL	Environmental Science Program
**Linfield College	OR	Environmental Studies Program
Lipscomb University	TN	Sustainability and Environmental Studies Program
Louisiana State University - Shreveport	LA	Environmental Science Program
Loyola University Chicago	IL	Environmental Science/Studies Program

Lynchburg College	VA	Environmental Science Program
*Macalester College	MN	Environmental Studies Department
Manchester College	IN	Environmental Studies Program
Marist College	NY	Environmental Science and Policy Program
Maryville College	TN	Environmental Studies Program
Meredith College	NC	Environmental Studies Program
Mesa State College	CO	Environmental Science and Technology
Messiah College	PA	Environmental Science and Studies Program
**Michigan State University	MI	Environmental Science and Policy Program
Michigan Technological University	MI	Environmental Policy Program
Michigan Technological University	MI	Applied Ecology and Environmental Sciences Program
Midland Lutheran College	NE	Environmental Science Composite Program
Montana State University - Billings	MT	Environmental Studies Program
Moravian College	PA	Environmental Studies Program
**Morgan State University	MD	Bio-environmental Sciences Doctoral Program
New York University	NY	Environmental Studies Program
**North Carolina A&T State University	NC	Plant, Soil and Environmental Science Program
**North Carolina State University	NC	Environmental Technology, Natural Resources, and Environmental Science Programs
North Carolina Wesleyan College	NC	Environmental Science Program
Ohio State University - Main Campus	OH	Environmental Science Graduate Program
Ohio University	OH	Environmental Studies Program
*Oklahoma State University - Main Campus	OK	Environmental Science Graduate Program
Olivet College	MI	Environmental Science Program
Oregon Institute of Technology	OR	Environmental Sciences Program
*Oregon State University	OR	Water Resources Graduate Program
Otterbein College	OH	Environmental Science Program
Our Lady of the Lake University of San Antonio	TX	Environmental Science Program
Pace University - New York	NY	Environmental Science Program
Pace University - New York	NY	Environmental Studies Program
Pacific University	OR	Environmental Studies Program
Pennsylvania State University - Main Campus	PA	Environmental Resource Management Program
Piedmont College	GA	Environmental Science Program
Principia College	IL	Biology and Natural Resources
*Purdue University - Main Campus	IN	Natural Resources and Environmental Science Program
Ramapo College of New Jersey	NJ	Environmental Studies Program
Randolph College	VA	Environmental Science and Studies Programs

Rider University	NJ	Environmental Science Program
Roanoke College	VA	Environmental Science and Policy Programs
Rochester Institute of Technology	NY	Environmental Science Program
Roger Williams University	RI	Environmental Science Program
Rollins College	FL	Environmental Studies Program
Salisbury University	MD	Environmental Issues Program
San Francisco University	CA	Geography-Resource Management and Environmental Planning Program
Santa Clara University	CA	Environmental Science and Studies Programs
Shenandoah University	VA	Environmental Studies Program
Sierra Nevada College	NV	Environmental Science and Policy Programs
Simmons College	MA	Environmental Science Program
Simons Rock College of Bard	MA	Environmental Studies Program
Skidmore College	NY	Environmental Studies Program
**Smith College	MA	Environmental Science and Policy Program
Southern Illinois University - Edwardsville	IL	Environmental Science Graduate Program
Southern New Hampshire University	NH	Environment, Ethics and Public Policy Program
**Spelman College	GA	Environmental Science and Studies Program
St. Anselm College	NH	Environmental Science Program
St. Edwards University	TX	Environmental Science and Policy Program
St. Lawrence University	NY	Environmental Studies Program
St. Louis University - Main Campus	MO	Environmental Science Program
St. Mary-of-the-Woods College	IN	Earth Literacy Graduate Program
St. Olaf College	MN	Environmental Studies Program
St. Vincent College	PA	Environmental Science Program
*SUNY at Binghamton	NY	Environmental Studies Program
SUNY at Buffalo	NY	Environmental Studies Program
SUNY College at Fredonia	NY	Environmental Science Program
*SUNY College at New Paltz	NY	Environmental Geochemical Science Program
SUNY College at Oneonta	NY	Environmental Sciences Program
SUNY College at Plattsburgh	NY	Environmental Science and Studies Program
SUNY College at Purchase	NY	Environmental Studies Program
SUNY College of Environmental Science and Forestry	NY	Department of Environmental Studies
SUNY Potsdam	NY	Environmental Studies Program
Tarleton State University	TX	Environmental Science Masters Program
Taylor University	IN	Environmental Science Program
Tennessee Technological University	TN	Environmental Sciences Doctoral Program
*Texas A&M University - Main	TX	Environmental Programs in the College of Geosciences
Texas A&M University - Corpus Christi	TX	Master of Public Administration-Environmental Science Program

The Richard Stockton College of New Jersey	NJ	Environmental Studies Program
Thiel College	PA	Environmental Sciences Program
*Towson University	MD	Environmental Science Graduate Program
Towson University	MD	Environmental Science and Studies Program
Trinity College	CT	Environmental Science Program
*Tufts University	MA	Urban and Environmental Policy and Planning Program
United States Military Academy	NY	Environmental Science Program
Unity College	ME	Environmental Analysis Program
Universidad Del Turabo	PR	Environmental Sciences Graduate Programs
University of Arkansas - Main Campus	AR	Environmental, Soil and Water Science Program
University of Arkansas - Main Campus	AR	Environmental Dynamics Doctoral Program
*University of California - Davis	CA	Environmental Science and Policy Department
University of California - Davis	CA	Environmental and Resource Sciences Program
University of California - Irvine	CA	Earth and Environmental Science Program
University of California - Riverside	CA	Environmental Sciences Graduate Program
University of California - San Diego	CA	Environmental Systems Program
University of California - Santa Cruz	CA	Environmental Studies Program
**University of Connecticut	CT	Environmental Science Program
University of Colorado - Boulder	CO	Environmental Studies Program
University of Colorado - Colorado Springs	CO	Geography and Environmental Studies Program
University of Evansville	IN	Environmental Studies Program
*University of Florida	FL	Natural Resource Conservation Program
*University of Florida	FL	Environmental Management in Agriculture and Natural Resources Program
**University of Georgia	GA	Agricultural and Environmental Sciences Program
University of Idaho	ID	Environmental Science Program
*University of Illinois - Champaign Urbana	IL	Natural Resources and Environmental Sciences Program
University of Illinois - Springfield	IL	Environmental Science and Studies Graduate Program
University of Indianapolis	IN	Environmental Sciences Program
University of Kentucky	KY	Natural Resource Management and Conservation Program
University of Maine	ME	Aquaculture, Marine Science, Oceanography, Marine Biology, Marine Policy, Dual M.Sc. in Marine Policy and Marine Sciences
University of Maine	ME	Ecology and Environmental Sciences Program
University of Maine	ME	Quaternary & Climate Studies Programs
University of Maine - Farmington	ME	Environmental Planning and Policy Program
University of Maine - Presque Isle	ME	Environmental Studies Program
*University of Maryland - College Park	MD	Environmental Policy Program

*University of Massachusetts - Amherst	MA	Environmental Sciences Program
University of Massachusetts - Amherst	MA	Natural Resources Studies Program, Forest Resources Graduate Program
University of Massachusetts - Boston	MA	Earth and Geographic Science and Environmental Sciences Graduate Programs
University of Massachusetts-School of Marine Sciences	MA	Marine Sciences and Technology Program
University of Miami	FL	Marine and Atmospheric Science Program
University of Michigan - Ann Arbor	MI	Program in the Environment
University of Michigan - Dearborn	MI	Environmental Studies
University of Minnesota - Twin Cities	MN	Science, Technology and Policy Masters Program
University of Minnesota - Twin Cities	MN	Environmental Science, Policy and Management Program
University of Minnesota - Twin Cities	MN	Water Resources Science Graduate Program
University of Montana - Missoula	MT	Environmental Studies Program
University of Montana - Western	MT	Environmental Sciences and Environmental Interpretation Programs
University of Nebraska-Lincoln	NE	Environmental Studies Program
University of Nebraska-Lincoln	NE	Water Science Program
University of Nevada - Las Vegas	NV	Department of Environmental Studies
University of New England	ME	Environmental Science and Studies Programs
University of New Hampshire - Main Campus	NH	Environmental Science Program
University of New Hampshire - Main Campus	NH	Natural Resources and Earth Systems Science Doctoral Program
University of New Mexico - Main Campus	NM	Environmental Science Program
University of New Mexico - Main Campus	NM	Water Resources Program
University of North Carolina - Pembroke	NC	Environmental Science Program
University of North Carolina - Wilmington	NC	Environmental Studies Programs
University of North Dakota	ND	Environmental Geography Program
**University of North Texas	TX	Environmental Science Program
University of Northern Iowa	IA	Environmental Geography Program
University of Pennsylvania	PA	Environmental Studies Program
University of Pittsburgh - Johnstown	PA	Environmental Studies Program
University of Pittsburgh - Main Campus	PA	Environmental Studies Program
University of Portland	OR	Environmental Studies Program
**University of Redlands	CA	Environmental Science, Environmental Studies and Environmental Management Programs

University of Rhode Island	RI	Environmental Economics and Management Program
University of Rhode Island	RI	Environmental Science and Management, Wildlife and Conservation Biology
University of Rio Grande	OH	Environmental Science Program
University of Rochester	NY	Environmental Science and Studies Programs
**University of Scranton	PA	Environmental Science Program
**University of South Carolina - Columbia	SC	School of the Environment
*University of Southern California	CA	Environmental Studies Program
*University of St. Francis - Joliet	IL	Environmental Science Program
University of St. Thomas	TX	Environmental Science and Studies Program
University of St. Thomas	MN	Environmental Studies Program
University of Tennessee	TN	Environmental and Soil Sciences Program
University of Texas - Arlington	TX	Environmental and Earth Sciences Program
*University of Texas - Austin	TX	Sustainable Design Program
University of Texas - El Paso	TX	Environmental Science and Engineering Doctoral Program
University of Texas - El Paso	TX	Environmental Science Program
University of the Pacific	CA	Environmental Studies Program
*University of Tulsa	OK	Environmental Policy Program
University of Vermont and State Agricultural College	VT	Environmental Sciences Undergraduate Program
University of Virginia - Main Campus	VA	Urban and Environmental Planning Program
University of Washington - Seattle Campus	WA	Program on the Environment
University of Washington - Tacoma Campus	WA	Environmental Science Program
University of West Georgia	GA	Environmental Science and Studies Program
University of Wisconsin - Madison	WI	Public Affairs-Energy and Environmental Policy Graduate Program
University of Wisconsin - Madison	WI	Environment and Resources Program
University of Wisconsin - Madison	WI	Conservation Biology and Sustainable Development Program
University of Wisconsin - Madison	WI	Water Resources Management
University of Wisconsin - Milwaukee	WI	Conservation and Environmental Science Program
University of Wisconsin - Stevens Point	WI	Natural Resources Graduate Program
*University of Wyoming	WY	Rangeland Ecology and Watershed Management Program
*University of Wyoming	WY	Earth System Science Program
Upper Iowa University	IA	Environmental Science Program
*Vassar College	NY	Environmental Studies Program
Villanova University	PA	Environmental Science and Studies Program
Warren Wilson College	NC	Environmental Studies Program
Washington and Jefferson	PA	Environmental Studies Program

College		
Wellesley College	MA	Environmental Studies Program
Western Carolina University	NC	Environmental Science Program
Westfield State College	MA	Environmental Science Program
William Paterson University of New Jersey	NJ	Department of Environmental Science
**Williams College	PA	Environmental Studies Program
Wilson College	PA	Environmental Studies Program
Winthrop University	SC	Environmental Sciences/Studies Program
Worchester Polytechnic University	MA	Environmental Studies Program
**Yale University	CT	School of Forestry and Environmental Studies

APPENDIX B – PHASE I SURVEY QUESTIONNAIRE

Part A: Perspectives on Environmental Program Curricula

1. What is your primary role(s) within your institution's environmental program(s)?
2. What is your official title?
   - ❑ Dean
   - ❑ Associate Dean
   - ❑ Director
   - ❑ Associate Director
   - ❑ Chair
   - ❑ Head
   - ❑ Coordinator
   - ❑ Other
3. How important (highly, moderately, minimally) is it to draw clear boundaries around the environmental profession and the environmental programs that prepare students for entry into it? Explain.
   - ❑ highly important
   - ❑ moderately important
   - ❑ minimally important
4. Various disciplinary approaches to environmental training have been suggested over the years. Which of these approaches, in your opinion, should guide environmental curriculum design, and why?
   - <u>Unidisciplinary</u> (uni = one; geometric metaphor = single point): take courses from only one discipline and apply that knowledge to environmental problems and questions
   - <u>Multidisciplinary</u> (multi = many; geometric metaphor = four points arranged at corners of a square): take courses from two or more related disciplines and leave it to the student to integrate the knowledge gained from them in addressing environmental problems and questions
   - <u>Interdisciplinary</u> (inter = between; geometric metaphor = four corners connected by lines thus forming a square): take courses addressing areas between disciplines, e.g., biochemistry to bridge biology and chemistry or social psychology to bridge psychology and sociology, and use this knowledge to address environmental problems and questions
   - <u>Transdisciplinary</u> (trans = across; geometric metaphor = diagonals crossing square thus filling its interior): take courses that integrate disciplinary paradigms and concepts, e.g., risk assessment that addresses physical, biological, engineering, economic, and political aspects of risk)
   - <u>Metadisciplinary</u> (meta = above; geometric metaphor = cube): take courses that synthesize disciplinary insights to evolve emergent views that are more than the sum of these insights, e.g., "systems" understanding of the relationships between and among human and natural systems that yield insights into how social welfare can be sustainably improved indefinitely

5. Which metaphor for environmental program curricula do you believe best corresponds to your view of how environmental program students should be trained, and why?

   - ❑ "Bricks and Mortar:" grounding in several disciplines cemented with cross-disciplinary skill sets
   - ❑ "T" or "Tree:" roots in one discipline with branches extending into related disciplines
   - ❑ Venn Diagram:" broad exposure to natural sciences, social sciences, business, engineering, and humanities with overlaps varying depending on the focus of the environmental program
   - ❑ Other metaphor (explain):

6. How important (highly, moderately, minimally) should each of the following five areas (arranged in alphabetical order) in environmental program curricula be, and why?

   a. Business (e.g., economics, management, administration, information systems, etc.):

      - ❑ highly important
      - ❑ moderately important
      - ❑ minimally important

   b. Engineering (e.g., environmental, civil, industrial, chemical, etc.):

      - ❑ highly important
      - ❑ moderately important
      - ❑ minimally important

   c. Humanities (e.g., English, communications, history, philosophy, ethics, etc.):

      - ❑ highly important
      - ❑ moderately important
      - ❑ minimally important

   d. Natural Sciences (physical sciences (chemistry, geology, etc.), life sciences (biology, health, etc.), and math):

      - ❑ highly important
      - ❑ moderately important
      - ❑ minimally important

   e. Social Sciences (e.g., political science, law, sociology, psychology, etc.):

      - ❑ highly important
      - ❑ moderately important
      - ❑ minimally important

7. Do you believe that core competencies should be defined for all academic environmental programs? Why or why not?

      - ❑ Yes
      - ❑ No

   Why or why not?

8. If you answered *"yes"* to Question 7, what should these core competencies include, and why?

   b. If you answered *"no"* to Question 7, do you believe that core competencies should be required but be tailored to particular environmental professions? Explain.

   Yes, but core competencies should be tailored to particular environmental professions
   No, core competencies should <u>not</u> be required at all

9. How important (highly, moderately, minimally) is the development of a common set of guidelines for environmental program curricula that can be used as criteria for professional certification? Explain.

   - ❑ highly important
   - ❑ moderately important
   - ❑ minimally important

10. How important (highly, moderately, minimally) is the involvement of clients (employers, constituents, benefactors, students) in defining environmental program curricula? Explain.

   - ❑ highly important
   - ❑ moderately important
   - ❑ minimally important

11. What differences, if any, should there be in preparing undergraduate students for graduate school and in preparing them for careers immediately after obtaining their undergraduate degree? Explain:

12. What differences should there be in undergraduate and graduate environmental program curricula? Explain:

Part B: Program Descriptions

1. What is the name of your institution?

2. How is/are your curriculum/curricula determined? In other words, who possesses curriculum decision-making authority, what process is used to define and revise curricula, and how are curricula reviewed?

3. Are you affiliated with an undergraduate program?

   - ❑ Yes
   - ❑ No (If no, skip to Question 4)

   a. What is the name of this program?

   b. How old is this program (years)?

   c. Where is this program administratively housed within the university or college?

   d. Approximately how many students are currently enrolled in this program?

   e. What is/are the title(s) of the degree(s) that this program awards?

      - ❑ BS
      - ❑ BA
      - ❑ Other

   f. How many hours are required for graduation for each undergraduate degree awarded?

      BS: semester hours OR quarter hours

      BA: semester hours OR quarter hours

      Other: semester hours OR quarter hours

   g. Is an undergraduate thesis required?

      - ❑ Yes
      - ❑ No
      - ❑ Sometimes

      If "yes" or "sometimes," explain:

h. Is an internship required?

- ❑ Yes
- ❑ No
- ❑ Sometimes

If “yes” or “sometimes,” explain:

i. Does this program include officially recognized focus/specialization/emphasis areas?

- ❑ Yes
- ❑ No
- ❑ Sometimes

If “yes” identify these areas:

j. Does this program have its own faculty?

- ❑ Yes, has own faculty
- ❑ No, relies on faculty from other academic units

k. For what environmental careers are your graduates best prepared?

4. Are you affiliated with a graduate program?

- ❑ Yes
- ❑ No

a. What is the name of this program?

b. How old is this program (years)?

c. Where is this program administratively housed within the university or college?

d. Approximately how many students are currently enrolled in this program?

e. What is/are the title(s) of the degree(s) that this program awards?

- ❑ MS
- ❑ MA
- ❑ PhD
- ❑ Other

f. How many hours are required for graduation for each undergraduate degree awarded?

MS: semester hours OR quarter hours

MA: semester hours OR quarter hours

PhD: semester hours OR quarter hours

Other semester hours OR quarter hours

g. Is a research-based thesis/dissertation required?

- ❑ Yes
- ❑ No
- ❑ Sometimes

If “yes” or “sometimes,” explain:

h. Is an internship required?

- ❑ Yes
- ❑ No
- ❑ Sometimes

If “yes” or “sometimes,” explain:

i. Does this program include officially recognized focus/specialization/emphasis areas?

- ❑ Yes
- ❑ No
- ❑ Sometimes

If “yes” identify these areas:

j. Does this program have its own faculty?

- ❑ Yes, has own faculty
- ❑ No, relies on faculty from other academic units

k. For what environmental careers are your graduates best prepared?

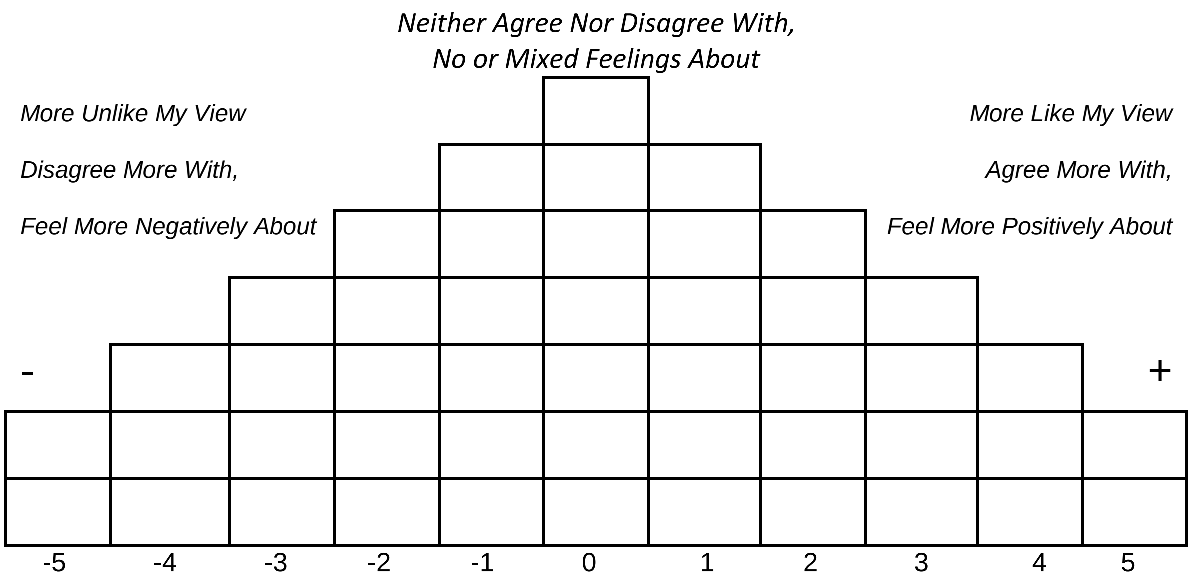
APPENDIX C – Q SAMPLE STATEMENTS

1. Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.
2. The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.
3. Environmental issues inherently transcend traditional disciplinary boundaries; therefore, environmental education should address problems in a way that goes beyond disciplinary thinking.
4. Programs need to be somewhat tailored to the strengths of a given institution.
5. Students must understand the human contexts---cultural, historical, philosophical, and ethical---of environmental issues.
6. All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.
7. Traditional disciplinary programs have developed core competencies; environmental programs should do the same.
8. There is a foundation of knowledge and skills that are central to understanding and solving environmental problems. These need to be incorporated into all programs.
9. Academics need the reality checks that can be provided by people outside the academy. Those who are the consumers of the talent pool, who seek a valuable educational experience, and who invest in the enterprise of education all have valuable insights.
10. Certification would be appropriate for some environment professions, but not others.
11. Undergraduate programs should have a research-based graduate school preparation track and a practical applications-based professional track.
12. Systems understanding, recognition of emergent properties, synthesized knowledge, and "thinking outside the box" are important goals of environmental education.
13. The student and his/her advisor should determine an individualized curriculum that is most appropriate for that student.
14. Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.
15. At the undergraduate level, curricula should emphasize basic understanding of a breadth of core disciplines.
16. Metadisciplinary training is desirable, but pragmatic issues of administration and disciplinary department relations limit programs to an interdisciplinary or a transdisciplinary approach.
17. Students need to understand how economic policies can damage the environment or be used as tools for solving environmental problems.
18. All students should have knowledge of the advantages and limits of technological fixes to environmental problems.
19. One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.
20. Environmental education should continue to follow its traditional focus on providing depth in a single discipline.
21. Core competencies should be defined broadly--more broadly than any single student could master---and students asked to demonstrate mastery of a subset.
22. It is important to include various clients in program development and planning to stay connected with market employment needs and evolving environmental concerns.
23. Core competencies are essential for professional certification and perhaps future program accreditation.

24. Because of the youth of the field and its interdisciplinary nature, core competencies for environmental programs should be sufficiently broad to encompass a variety of different approaches.
25. Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.
26. The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.
27. Since there is no single environmental profession, there needs to be individual certifications for each niche.
28. Undergraduate students directly entering the workforce need more breadth, while those preparing for graduate school need more depth.
29. Environmental programs cannot be client-based because is difficult to identify just who is a client.
30. Certification is a bad idea because it would stifle innovation, limit participation, and force program homogeneity.
31. Defining core competencies will have the effect of drawing a wall around the environmental field, which will adversely affect program flexibility, inclusiveness, and participation.
32. Students need to understand business language and paradigms because of the importance of economic considerations in environmental decision-making.
33. Environmental decisions should be made rationally. Students should learn decision theory techniques such as benefit/cost analysis, risk analysis or other optimization strategies.
34. It is essential for students to understand the interface between nature and social systems---how societies impact the environment and how the environment impacts societies.
35. Client involvement is important for program support and overall success.
36. At the graduate level, curricula should focus on more specialized areas.
37. Undergraduate preparation for graduate school or an immediate career should be the same to prepare students for life-long learning and critical thinking.
38. Client interests are not always compatible with academic goals. It's the faculty's prerogative to develop curricula, not the clients.
39. Students need to understand the limits of scientific studies and learn to appreciate, quantify, and accurately report uncertainties.
40. It is important for students to gain an understanding of environmental conflicts between competing interests, such as utilitarian versus preservationist, individual versus public, local versus global, and current versus future generations.
41. It is important that all students have exposure to a broad range of subjects, including the humanities and the natural, social, and applied sciences.
42. Program boundaries should be clear enough to demarcate the center from the periphery, but the edges should be fuzzy.
43. Hard boundaries limit the perspectives that can be brought to bear on environmental problems, which require interdisciplinary solutions.
44. Graduate programs should include both a professional non -thesis track and a research-based thesis track.
45. The environmental profession is still evolving and its too early to develop highly defined boundaries.
46. The goal of environmental programs should be to be inclusive of anyone who wants to participate, and to avoid walls.
47. Program boundaries are important to avoid unnecessary turf wars with other majors and programs.

APPENDIX D – Q SORT FORM BOARD

What is your view of how environmental program curricula should be designed?



Summary of My View:

APPENDIX E: Q ANALYSIS RESULTS

Table 35. Initial (Varimax) rotation: factor extraction results

Factor	A	B	C	Total
Explained Variance	20%	19%	14%	53%

Table 36. Varimax rotation: factor correlations

Factor	A	B	C
A	1.0	.66	.42
B	.66	1.0	.41
C	-	-	1.0
Reliabilities	99	98	98
Std. Errors	12	14	15

Table 37. Initial (Varimax) rotation: factor loads

Participant	A	B	C
1	.62*	.50*	.12
2	.15	.61*	.48*
3	.38	.72*	.21
4	.29	-.05	.54*
5	.51*	.65*	.06
6	.73*	.10	-.03
7	.09	.24	.50
8	.32	.43	.34
9	.40	.74*	-.05
10	.69*	.23	.34
11	-.10	.73*	.31
12	.32	.12	.74*
13	.72*	.13	.19
14	.06	.29	.45*
15	.37	.62*	.32
16	.60*	.41	.34
17	-.02	-.00	.79*
18	.69*	.12	.13
19	.63*	.54*	.09
20	.46*	.30	.44
21	.26	.30	.43
22	.58*	.42	.06
23	-.13	.61*	.18
24	.26	.63*	.20
25	.73*	.44	-.11
26	.25	.44	.53*
27	.25	.67*	.34
28	.12	.05	.75*
29	.12	.56*	.11
30	-.07	.37	.66*
31	.53*	.54*	-.17

Table 37. Initial (Varimax) rotation: factor loads (continued)

Participant	A	B	C
32	.59*	.22	.06
33	.48*	.19	.35
34	.37	.58*	-.33
35	.39	.14	.25
36	.35	.42	.30
37	.74*	-.16	.13
38	.31	.65*	.03
39	.02	-.06	.54*
40	.40	.52*	.31
41	.46*	.10	.29
42	.26	.08	.78*
43	.65*	.17	.22
44	.75*	.41	.18

* Denote loadings significant at 0.451, at p<0.001

Table 38. Initial (Varimax) rotation: non-significant loaders

Participant	A	B	C
8	.32	.34	.43
21	.26	.43	.30
35	.39	.25	.14
36	.35	.30	.42

Table 39. Initial (Varimax) rotation: statement scores

		Placement		
Item	Statement	A	B	C
1.	Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.	0	-4	4
2.	The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.	2	0	-3
3.	Environmental issues inherently transcend traditional disciplinary boundaries; therefore, environmental education should address problems in a way that goes beyond disciplinary thinking.	5	4	2
4.	Programs need to be somewhat tailored to the strengths of a given institution.	3	1	2
5.	Students must understand the human contexts—cultural, historical, philosophical, and ethical—of environmental issues.	5	4	1
6.	All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.	4	1	5
7.	Traditional disciplinary programs have developed core competencies; environmental programs should do the same.	-1	-2	3
8.	There is a foundation of knowledge and skills that are central to understanding and solving environmental problems. These need to be incorporated into all programs.	0	-2	5
9.	Academics need the reality checks that can be provided by people outside the academy. Those who are the consumers of the talent pool, who seek a valuable educational experience, and who invest in the enterprise of education all have valuable insights.	-1	2	1
10.	Certification would be appropriate for some environment professions, but not others.	-3	0	-2

Table 39. Initial (Varimax) rotation: statement scores (continued)

Item	Statement	Placement A	B	C
11.	Undergraduate programs should have a research-based graduate school preparation track and a practical applications-based professional track.	-5	-2	-3
12.	Systems understanding, recognition of emergent properties, synthesized knowledge, and "thinking outside the box" are important goals of environmental education.	2	4	1
13.	The student and his/her advisor should determine an individualized curriculum that is most appropriate for that student.	-2	-1	-4
14.	Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.	-4	-2	1
15.	At the undergraduate level, curricula should emphasize basic understanding of a breadth of core disciplines.	1	0	0
16.	Metadisciplinary training is desirable, but pragmatic issues of administration and disciplinary department relations limit programs to an interdisciplinary or a transdisciplinary approach.	-2	0	0
17.	Students need to understand how economic policies can damage the environment or be used as tools for solving environmental problems.	3	2	2
18.	All students should have knowledge of the advantages and limits of technological fixes to environmental problems.	2	2	3
19.	One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.	4	5	4
20.	Environmental education should continue to follow its traditional focus on providing depth in a single discipline.	-4	-5	-2
21.	Core competencies should be defined broadly—more broadly than any single student could master—and students asked to demonstrate mastery of a subset.	-1	-2	0
22.	It is important to include various clients in program development and planning to stay connected with market employment needs and evolving environmental concerns.	-2	2	0
23.	Core competencies are essential for professional certification and perhaps future program accreditation.	-3	-3	1
24.	Because of the youth of the field and its interdisciplinary nature, core competencies for environmental programs should be sufficiently broad to encompass a variety of different approaches.	0	1	-1
25.	Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.	-4	-3	3
26.	The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.	1	3	0
27.	Since there is no single environmental profession, there needs to be individual certifications for each niche.	-5	-3	-2
28.	Undergraduate students directly entering the workforce need more breadth, while those preparing for graduate school need more depth.	-2	-4	-3
29.	Environmental programs cannot be client-based because is difficult to identify just who is a client.	0	-5	-4
30.	Certification is a bad idea because it would stifle innovation, limit participation, and force program homogeneity.	1	-1	-4

Table 39. Initial (Varimax) rotation: statement scores (continued)

Item	Statement	Placement A	B	C
31.	Defining core competencies will have the effect of drawing a wall around the environmental field, which will adversely affect program flexibility, inclusiveness, and participation.	0	-1	-5
32.	Students need to understand business language and paradigms because of the importance of economic considerations in environmental decision-making.	0	0	-1
33.	Environmental decisions should be made rationally. Students should learn decision theory techniques such as benefit/cost analysis, risk analysis or other optimization strategies.	0	2	1
34.	It is essential for students to understand the interface between nature and social systems—how societies impact the environment and how the environment impacts societies.	4	5	4
35.	Client involvement is important for program support and overall success.	-3	1	-1
36.	At the graduate level, curricula should focus on more specialized areas.	1	-1	2
37.	Undergraduate preparation for graduate school or an immediate career should be the same to prepare students for life-long learning and critical thinking.	1	1	0
38.	Client interests are not always compatible with academic goals. It's the faculty's prerogative to develop curricula, not the clients.	3	-3	-2
39.	Students need to understand the limits of scientific studies and learn to appreciate, quantify, and accurately report uncertainties.	2	3	3
40.	It is important for students to gain an understanding of environmental conflicts between competing interests, such as utilitarian versus preservationist, individual versus public, local versus global, and current versus future generations.	3	3	0
41.	It is important that all students have exposure to a broad range of subjects, including the humanities and the natural, social, and applied sciences.	2	3	2
42.	Program boundaries should be clear enough to demarcate the center from the periphery, but the edges should be fuzzy.	-1	0	-1
43.	Hard boundaries limit the perspectives that can be brought to bear on environmental problems, which require interdisciplinary solutions.	1	0	-1
44.	Graduate programs should include both a professional non-thesis track and a research-based thesis track.	-1	1	-1
45.	The environmental profession is still evolving and its too early to develop highly defined boundaries.	-1	-1	-3
46.	The goal of environmental programs should be to be inclusive of anyone who wants to participate, and to avoid walls.	-2	-1	-5
47.	Program boundaries are important to avoid unnecessary turf wars with other majors and programs.	-3	-4	-2

Table 40. Initial (Varimax) rotation: consensus statements
(within 1 unit)

Item	Statement	Placement A	B	C
19.	One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.	4	5	4
34.	It is essential for students to understand the interface between nature and social systems—how societies impact the environment and how the environment impacts societies.	4	5	4

Table 40. Initial (Varimax) rotation: consensus statements (continued)

Item	Statement	Placement A	B	C
39.	Students need to understand the limits of scientific studies and learn to appreciate, quantify, and accurately report uncertainties.	2	3	3
17.	Students need to understand how economic policies can damage the environment or be used as tools for solving environmental problems.	3	2	2
18.	All students should have knowledge of the advantages and limits of technological fixes to environmental problems.	2	2	3
41.	It is important that all students have exposure to a broad range of subjects, including the humanities and the natural, social, and applied sciences.	2	3	2
37.	Undergraduate preparation for graduate school or an immediate career should be the same to prepare students for life-long learning and critical thinking.	1	1	0
15.	At the undergraduate level, curricula should emphasize basic understanding of a breadth of core disciplines.	1	0	0
32.	Students need to understand business language and paradigms because of the importance of economic considerations in environmental decision-making.	0	0	-1

Table 41. Initial (Varimax) rotation: descending array of differences between factors A and B

Item	Statement	A	B	Difference
29.	Environmental programs cannot be client-based because is difficult to identify just who is a client.	0.340	-1.760	2.100
38.	Client interests are not always compatible with academic goals. It's the faculty's prerogative to develop curricula, not the clients.	0.862	-1.117	1.979
1.	Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.	0.139	-1.355	1.494
6.	All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.	1.432	0.139	1.294
36.	At the graduate level, curricula should focus on more specialized areas.	0.676	-0.447	1.123
4.	Programs need to be somewhat tailored to the strengths of a given institution.	1.287	0.310	0.977
20.	Environmental education should continue to follow its traditional focus on providing depth in a single discipline.	-1.410	-2.309	0.899
30.	Certification is a bad idea because it would stifle innovation, limit participation, and force program homogeneity.	0.444	-0.401	0.845
8.	There is a foundation of knowledge and skills that are central to understanding and solving environmental problems. These need to be incorporated into all programs.	0.031	-0.808	0.839
2.	The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.	0.751	0.001	0.749
15.	At the undergraduate level, curricula should emphasize basic understanding of a breadth of core disciplines.	0.481	-0.011	0.492

Table 41. Initial (Varimax) rotation: descending array of differences between factors A and B (continued)

Item	Statement	A	B	Difference
31.	Defining core competencies will have the effect of drawing a wall around the environmental field, which will adversely affect program flexibility, inclusiveness, and participation.	0.115	-0.376	0.491
28.	Undergraduate students directly entering the workforce need more breadth, while those preparing for graduate school need more depth.	-0.781	-1.244	0.463
5.	Students must understand the human contexts—cultural, historical, philosophical, and ethical—of environmental issues.	1.783	1.434	0.349
37.	Undergraduate preparation for graduate school or an immediate career should be the same to prepare students for life-long learning and critical thinking.	0.506	0.166	0.339
43.	Hard boundaries limit the perspectives that can be brought to bear on environmental problems, which require interdisciplinary solutions.	0.414	0.090	0.324
21.	Core competencies should be defined broadly—more broadly than any single student could master—and students asked to demonstrate mastery of a subset.	-.0.449	-0.686	0.236
17.	Students need to understand how economic policies can damage the environment or be used as tools for solving environmental problems.	1.058	0.921	0.137
7.	Traditional disciplinary programs have developed core competencies; environmental programs should do the same.	-0.636	-0.763	0.128
45.	The environmental profession is still evolving and it’s too early to develop highly defined boundaries.	-0.292	-0.312	0.020
18.	All students should have knowledge of the advantages and limits of technological fixes to environmental problems.	0.707	0.704	0.003
23.	Core competencies are essential for professional certification and perhaps future program accreditation.	-1.013	-0.983	-0.031
3.	Environmental issues inherently transcend traditional disciplinary boundaries; therefore, environmental education should address problems in a way that goes beyond disciplinary thinking.	1.753	1.789	-0.036
33.	Environmental decisions should be made rationally. Students should learn decision theory techniques such as benefit/cost analysis, risk analysis or other optimization strategies.	0.324	0.416	-0.092
24.	Because of the youth of the field and its interdisciplinary nature, core competencies for environmental programs should be sufficiently broad to encompass a variety of different approaches.	0.224	0.395	-0.172
47.	Program boundaries are important to avoid unnecessary turf wars with other majors and programs.	-1.403	-1.221	-0.183
46.	The goal of environmental programs should be to be inclusive of anyone who wants to participate, and to avoid walls.	-0.682	-0.436	-0.246
40.	It is important for students to gain an understanding of environmental conflicts between competing interests, such as utilitarian versus preservationist, individual versus public, local versus global, and current versus future generations.	0.933	1.231	-0.299
32.	Students need to understand business language and paradigms because of the importance of economic considerations in environmental decision-making.	-0.231	0.079	-0.310

Table 41. Initial (Varimax) rotation: descending array of differences between factors A and B (continued)

Item	Statement	A	B	Difference
39.	Students need to understand the limits of scientific studies and learn to appreciate, quantify, and accurately report uncertainties.	0.784	1.102	-0.318
19.	One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.	1.666	1.988	-0.322
41.	It is important that all students have exposure to a broad range of subjects, including the humanities and the natural, social, and applied sciences.	0.714	1.084	-0.370
25.	Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.	-1.544	-1.048	-0.496
42.	Program boundaries should be clear enough to demarcate the center from the periphery, but the edges should be fuzzy.	-0.587	-0.065	-0.522
13.	The student and his/her advisor should determine an individualized curriculum that is most appropriate for that student.	-0.761	-0.207	-0.554
34.	It is essential for students to understand the interface between nature and social systems—how societies impact the environment and how the environment impacts societies.	1.444	2.121	-0.678
12.	Systems understanding, recognition of emergent properties, synthesized knowledge, and "thinking outside the box" are important goals of environmental education.	0.754	1.463	-0.709
44.	Graduate programs should include both a professional non - thesis track and a research-based thesis track.	-0.525	0.194	-0.719
16.	Metadisciplinary training is desirable, but pragmatic issues of administration and disciplinary department relations limit programs to an interdisciplinary or a transdisciplinary approach.	-0.957	-0.184	-0.772
26.	The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.	0.379	1.158	-0.779
27.	Since there is no single environmental profession, there needs to be individual certifications for each niche.	-1.891	-1.066	-0.825
14.	Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.	-1.618	-0.774	-0.844
10.	Certification would be appropriate for some environment professions, but not others.	-1.060	-0.146	-0.914
11.	Undergraduate programs should have a research-based graduate school preparation track and a practical applications-based professional track.	-1.822	-0.888	-0.934
22.	It is important to include various clients in program development and planning to stay connected with market employment needs and evolving environmental concerns.	-0.740	0.451	-1.191
9.	Academics need the reality checks that can be provided by people outside the academy. Those who are the consumers of the talent pool, who seek a valuable educational experience, and who invest in the enterprise of education all have valuable insights.	-0.512	0.966	-1.478
35.	Client involvement is important for program support and overall success.	-1.087	0.402	-1.490

Table 42. Initial (Varimax) rotation: descending array of differences between factors A and C

Item	Statement	A	C	Difference
31.	Defining core competencies will have the effect of drawing a wall around the environmental field, which will adversely affect program flexibility, inclusiveness, and participation.	0.115	-2.259	2.374
30.	Certification is a bad idea because it would stifle innovation, limit participation, and force program homogeneity.	0.444	-1.474	1.919
29.	Environmental programs cannot be client-based because is difficult to identify just who is a client.	0.340	-1.404	1.744
38.	Client interests are not always compatible with academic goals. It's the faculty's prerogative to develop curricula, not the clients.	0.862	-0.742	1.604
2.	The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.	0.751	-0.816	1.566
46.	The goal of environmental programs should be to be inclusive of anyone who wants to participate, and to avoid walls.	-0.682	-2.007	1.325
5.	Students must understand the human contexts—cultural, historical, philosophical, and ethical—of environmental issues.	1.783	0.604	1.179
45.	The environmental profession is still evolving and it's too early to develop highly defined boundaries.	-0.292	-1.347	1.055
43.	Hard boundaries limit the perspectives that can be brought to bear on environmental problems, which require interdisciplinary solutions.	0.414	-0.529	0.943
13.	The student and his/her advisor should determine an individualized curriculum that is most appropriate for that student.	-0.761	-1.689	0.928
40.	It is important for students to gain an understanding of environmental conflicts between competing interests, such as utilitarian versus preservationist, individual versus public, local versus global, and current versus future generations.	0.933	0.146	0.787
3.	Environmental issues inherently transcend traditional disciplinary boundaries; therefore, environmental education should address problems in a way that goes beyond disciplinary thinking.	1.753	0.990	0.762
24.	Because of the youth of the field and its interdisciplinary nature, core competencies for environmental programs should be sufficiently broad to encompass a variety of different approaches.	0.224	-0.440	0.664
15.	At the undergraduate level, curricula should emphasize basic understanding of a breadth of core disciplines.	0.481	-0.109	0.591
37.	Undergraduate preparation for graduate school or an immediate career should be the same to prepare students for life-long learning and critical thinking.	0.506	-0.079	0.584
26.	The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.	0.379	-0.174	0.553
19.	One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.	1.666	1.223	0.443
4.	Programs need to be somewhat tailored to the strengths of a given institution.	1.287	0.912	0.375
12.	Systems understanding, recognition of emergent properties, synthesized knowledge, and "thinking outside the box" are important goals of environmental education.	0.754	0.459	0.295

Table 42. Initial (Varimax) rotation: descending array of differences between factors A and C (continued)

Item	Statement	A	C	Difference
17.	Students need to understand how economic policies can damage the environment or be used as tools for solving environmental problems.	1.058	0.802	0.256
28.	Undergraduate students directly entering the workforce need more breadth, while those preparing for graduate school need more depth.	-0.781	-0.886	0.105
32.	Students need to understand business language and paradigms because of the importance of economic considerations in environmental decision-making.	-0.231	-0.189	-0.042
34.	It is essential for students to understand the interface between nature and social systems—how societies impact the environment and how the environment impacts societies.	1.444	1.489	-0.045
41.	It is important that all students have exposure to a broad range of subjects, including the humanities and the natural, social, and applied sciences.	0.714	0.788	-0.074
44.	Graduate programs should include both a professional non - thesis track and a research-based thesis track.	-0.525	-0.404	-0.121
36.	At the graduate level, curricula should focus on more specialized areas.	0.676	0.902	-0.226
39.	Students need to understand the limits of scientific studies and learn to appreciate, quantify, and accurately report uncertainties.	0.784	1.038	-0.254
18.	All students should have knowledge of the advantages and limits of technological fixes to environmental problems.	0.707	0.991	-0.284
42.	Program boundaries should be clear enough to demarcate the center from the periphery, but the edges should be fuzzy.	-0.587	-0.247	-0.340
33.	Environmental decisions should be made rationally. Students should learn decision theory techniques such as benefit/cost analysis, risk analysis or other optimization strategies.	0.324	0.676	-0.352
21.	Core competencies should be defined broadly—more broadly than any single student could master—and students asked to demonstrate mastery of a subset.	-0.449	-0.088	-0.361
10.	Certification would be appropriate for some environment professions, but not others.	-1.060	-0.684	-0.376
6.	All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.	1.432	1.856	-0.424
11.	Undergraduate programs should have a research-based graduate school preparation track and a practical applications-based professional track.	-1.822	-1.272	-0.551
47.	Program boundaries are important to avoid unnecessary turf wars with other majors and programs.	-1.403	-0.721	-0.682
20.	Environmental education should continue to follow its traditional focus on providing depth in a single discipline.	-1.410	-0.718	-0.692
22.	It is important to include various clients in program development and planning to stay connected with market employment needs and evolving environmental concerns.	-0.740	-0.045	-0.695

Table 42. Initial (Varimax)rotation: descending array of differences between factors A and C (continued)

Item	Statement	A	C	Difference
35.	Client involvement is important for program support and overall success.	-1.087	-0.302	-0.786
9.	Academics need the reality checks that can be provided by people outside the academy. Those who are the consumers of the talent pool, who seek a valuable educational experience, and who invest in the enterprise of education all have valuable insights.	-0.512	0.337	-0.849
16.	Metadisciplinary training is desirable, but pragmatic issues of administration and disciplinary department relations limit programs to an interdisciplinary or a transdisciplinary approach.	-0.957	0.079	-1.036
1.	Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.	0.139	1.289	-1.150
27.	Since there is no single environmental profession, there needs to be individual certifications for each niche.	-1.891	-0.702	-1.189
23.	Core competencies are essential for professional certification and perhaps future program accreditation.	-1.013	0.469	-1.483
8.	There is a foundation of knowledge and skills that are central to understanding and solving environmental problems. These need to be incorporated into all programs.	0.031	1.680	-1.650
7.	Traditional disciplinary programs have developed core competencies; environmental programs should do the same.	-0.636	1.152	-1.788
14.	Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.	-1.618	0.397	-2.015
25.	Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.	-1.544	1.044	-2.588

Table 43. Initial (Varimax) rotation: descending array of differences between factors B and C

Item	Statement	B	C	Difference
1.	Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.	-1.355	1.289	2.644
8.	There is a foundation of knowledge and skills that are central to understanding and solving environmental problems. These need to be incorporated into all programs.	-0.808	1.680	2.488
25.	Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.	-1.048	1.044	2.092
7.	Traditional disciplinary programs have developed core competencies; environmental programs should do the same.	-0.763	1.152	1.915
6.	All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.	0.139	1.856	1.717
20.	Environmental education should continue to follow its traditional focus on providing depth in a single discipline.	-2.309	-0.718	1.590
23.	Core competencies are essential for professional certification and perhaps future program accreditation.	-0.983	0.469	1.452

Table 43. Initial (Varimax) rotation: descending array of differences between factors B and C (continued)

Item	Statement	B	C	Difference
36.	At the graduate level, curricula should focus on more specialized areas.	-0.447	0.902	1.349
14.	Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.	-0.774	0.397	1.171
4.	Programs need to be somewhat tailored to the strengths of a given institution.	0.310	0.912	0.602
21.	Core competencies should be defined broadly—more broadly than any single student could master—and students asked to demonstrate mastery of a subset.	-0.686	-0.088	0.598
47.	Program boundaries are important to avoid unnecessary turf wars with other majors and programs.	-1.221	-0.721	0.499
38.	Client interests are not always compatible with academic goals. It's the faculty's prerogative to develop curricula, not the clients.	-1.117	-0.742	0.375
27.	Since there is no single environmental profession, there needs to be individual certifications for each niche.	-1.066	-0.702	0.364
28.	Undergraduate students directly entering the workforce need more breadth, while those preparing for graduate school need more depth.	-1.244	-0.886	0.358
29.	Environmental programs cannot be client-based because is difficult to identify just who is a client.	-1.760	-1.404	0.357
18.	All students should have knowledge of the advantages and limits of technological fixes to environmental problems.	0.704	0.991	0.287
16.	Metadisciplinary training is desirable, but pragmatic issues of administration and disciplinary department relations limit programs to an interdisciplinary or a transdisciplinary approach.	-0.184	0.079	0.264
33.	Environmental decisions should be made rationally. Students should learn decision theory techniques such as benefit/cost analysis, risk analysis or other optimization strategies.	0.416	0.676	0.260
39.	Students need to understand the limits of scientific studies and learn to appreciate, quantify, and accurately report uncertainties.	1.102	1.038	-0.064
15.	At the undergraduate level, curricula should emphasize basic understanding of a breadth of core disciplines.	-0.011	-0.109	-0.099
17.	Students need to understand how economic policies can damage the environment or be used as tools for solving environmental problems.	0.921	0.802	-0.119
42.	Program boundaries should be clear enough to demarcate the center from the periphery, but the edges should be fuzzy.	-0.065	-0.247	0.182
37.	Undergraduate preparation for graduate school or an immediate career should be the same to prepare students for life-long learning and critical thinking.	0.166	-0.079	-0.245
32.	Students need to understand business language and paradigms because of the importance of economic considerations in environmental decision-making.	0.079	-0.189	-0.268
41.	It is important that all students have exposure to a broad range of subjects, including the humanities and the natural, social, and applied sciences.	1.084	0.788	-0.296
11.	Undergraduate programs should have a research-based graduate school preparation track and a practical applications-based professional track.	-0.888	-1.272	-0.383

Table 43. Initial (Varimax) rotation: descending array of differences between factors B and C (continued)

Item	Statement	B	C	Difference
22.	It is important to include various clients in program development and planning to stay connected with market employment needs and evolving environmental concerns.	0.451	-0.045	-0.496
10.	Certification would be appropriate for some environment professions, but not others.	-0.146	-0.684	-0.583
44.	Graduate programs should include both a professional non -thesis track and a research-based thesis track.	0.194	-0.404	-0.597
43.	Hard boundaries limit the perspectives that can be brought to bear on environmental problems, which require interdisciplinary solutions.	0.090	-0.529	-0.619
9.	Academics need the reality checks that can be provided by people outside the academy. Those who are the consumers of the talent pool, who seek a valuable educational experience, and who invest in the enterprise of education all have valuable insights.	0.966	0.337	-0.629
34.	It is essential for students to understand the interface between nature and social systems—how societies impact the environment and how the environment impacts societies.	2.121	1.489	-0.633
35.	Client involvement is important for program support and overall success.	0.402	-0.302	-0.704
19.	One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.	1.988	1.223	-0.765
3.	Environmental issues inherently transcend traditional disciplinary boundaries; therefore, environmental education should address problems in a way that goes beyond disciplinary thinking.	1.789	0.990	-0.799
2.	The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.	0.001	-0.816	-0.817
5.	Students must understand the human contexts—cultural, historical, philosophical, and ethical—of environmental issues.	1.434	0.604	-0.830
24.	Because of the youth of the field and its interdisciplinary nature, core competencies for environmental programs should be sufficiently broad to encompass a variety of different approaches.	0.395	-0.440	0.835
12.	Systems understanding, recognition of emergent properties, synthesized knowledge, and "thinking outside the box" are important goals of environmental education.	1.463	0.459	-1.004
45.	The environmental profession is still evolving and it’s too early to develop highly defined boundaries.	-0.312	-1.347	-1.035
30.	Certification is a bad idea because it would stifle innovation, limit participation, and force program homogeneity.	-0.401	-1.474	-1.074
40.	It is important for students to gain an understanding of environmental conflicts between competing interests, such as utilitarian versus preservationist, individual versus public, local versus global, and current versus future generations.	1.231	0.146	-1.085
26.	The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.	1.158	-0.174	-1.332
13.	The student and his/her advisor should determine an individualized curriculum that is most appropriate for that student.	-0.207	-1.689	-1.482
46.	The goal of environmental programs should be to be inclusive of anyone who wants to participate, and to avoid walls.	-0.436	-2.007	-1.571

Table 43. Initial (Varimax) rotation: descending array of differences between factors B and C (continued)

Item	Statement	B	C	Difference
31.	Defining core competencies will have the effect of drawing a wall around the environmental field, which will adversely affect program flexibility, inclusiveness, and participation.	-0.376	-2.259	-1.883

Figure 14. Factor A common sort

					1					
				7	8	15				
			13	9	24	26	2			
		10	16	21	29	30	12	4		
	14	23	22	42	31	36	18	17	6	
11	20	35	28	44	32	37	39	38	19	3
27	25	47	46	45	33	43	41	40	34	5
-5	-4	-3	-2	-1	0	1	2	3	4	5

Table 44. Factor A descending z-score array

Item	Statement	Z-score
5.	Students must understand the human contexts—cultural, historical, philosophical, and ethical—of environmental issues.	1.783
3.	Environmental issues inherently transcend traditional disciplinary boundaries; therefore, environmental education should address problems in a way that goes beyond disciplinary thinking.	1.753
19.	One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.	1.666
34.	It is essential for students to understand the interface between nature and social systems—how societies impact the environment and how the environment impacts societies.	1.444
6.	All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.	1.432
4.	Programs need to be somewhat tailored to the strengths of a given institution.	1.287
17.	Students need to understand how economic policies can damage the environment or be used as tools for solving environmental problems.	1.058
40.	It is important for students to gain an understanding of environmental conflicts between competing interests, such as utilitarian versus preservationist, individual versus public, local versus global, and current versus future generations.	0.933
38.	Client interests are not always compatible with academic goals. It's the faculty's prerogative to develop curricula, not the clients.	0.862
39.	Students need to understand the limits of scientific studies and learn to appreciate, quantify, and accurately report uncertainties.	0.784
12.	Systems understanding, recognition of emergent properties, synthesized knowledge, and "thinking outside the box" are important goals of environmental education.	0.754
2.	The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.	0.751
41.	It is important that all students have exposure to a broad range of subjects, including the humanities and the natural, social, and applied sciences.	0.714
18.	All students should have knowledge of the advantages and limits of technological fixes to environmental problems.	0.707
36.	At the graduate level, curricula should focus on more specialized areas.	0.676

Table 44. Factor A descending z-score array (continued)

Item	Statement	Z-score
37.	Undergraduate preparation for graduate school or an immediate career should be the same to prepare students for life-long learning and critical thinking.	0.506
15.	At the undergraduate level, curricula should emphasize basic understanding of a breadth of core disciplines.	0.481
30.	Certification is a bad idea because it would stifle innovation, limit participation, and force program homogeneity.	0.444
43.	Hard boundaries limit the perspectives that can be brought to bear on environmental problems, which require interdisciplinary solutions.	0.414
26.	The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.	0.379
29.	Environmental programs cannot be client-based because is difficult to identify just who is a client.	0.340
33.	Environmental decisions should be made rationally. Students should learn decision theory techniques such as benefit/cost analysis, risk analysis or other optimization strategies.	0.324
24.	Because of the youth of the field and its interdisciplinary nature, core competencies for environmental programs should be sufficiently broad to encompass a variety of different approaches.	0.224
1.	Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.	0.139
31.	Defining core competencies will have the effect of drawing a wall around the environmental field, which will adversely affect program flexibility, inclusiveness, and participation.	0.115
8.	There is a foundation of knowledge and skills that are central to understanding and solving environmental problems. These need to be incorporated into all programs.	0.031
32.	Students need to understand business language and paradigms because of the importance of economic considerations in environmental decision-making.	-0.231
45.	The environmental profession is still evolving and its too early to develop highly defined boundaries.	-0.292
21.	Core competencies should be defined broadly—more broadly than any single student could master—and students asked to demonstrate mastery of a subset.	-0.449
9.	Academics need the reality checks that can be provided by people outside the academy. Those who are the consumers of the talent pool, who seek a valuable educational experience, and who invest in the enterprise of education all have valuable insights.	-0.512
44.	Graduate programs should include both a professional non-thesis track and a research-based thesis track.	-0.525
42.	Program boundaries should be clear enough to demarcate the center from the periphery, but the edges should be fuzzy.	-0.587
7.	Traditional disciplinary programs have developed core competencies; environmental programs should do the same.	-0.636
46.	The goal of environmental programs should be to be inclusive of anyone who wants to participate, and to avoid walls.	-0.682
22.	It is important to include various clients in program development and planning to stay connected with market employment needs and evolving environmental concerns.	-0.740
13.	The student and his/her advisor should determine an individualized curriculum that is most appropriate for that student.	-0.761

Table 44. Factor A descending z-score array (continued)

Item	Statement	Z-score
28.	Undergraduate students directly entering the workforce need more breadth, while those preparing for graduate school need more depth.	-0.781
16.	Metadisciplinary training is desirable, but pragmatic issues of administration and disciplinary department relations limit programs to an interdisciplinary or a transdisciplinary approach.	-0.957
23.	Core competencies are essential for professional certification and perhaps future program accreditation.	-1.013
10.	Certification would be appropriate for some environment professions, but not others.	-1.060
35.	Client involvement is important for program support and overall success.	-1.087
47.	Program boundaries are important to avoid unnecessary turf wars with other majors and programs.	-1.403
20.	Environmental education should continue to follow its traditional focus on providing depth in a single discipline.	-1.410
25.	Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.	-1.544
14.	Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.	-1.618
11.	Undergraduate programs should have a research-based graduate school preparation track and a practical applications-based professional track.	-1.822
27.	Since there is no single environmental profession, there needs to be individual certifications for each niche.	-1.891

Table 45. Factor A distinguishing statements
(20 items distinguish factor A from other factors)

Item	Statement	Placement A	B	C
6.	All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.	4	1	5
38.	Client interests are not always compatible with academic goals. It's the faculty's prerogative to develop curricula, not the clients.	3	-3	-2
2.	The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.	2	0	-3
15.	At the undergraduate level, curricula should emphasize basic understanding of a breadth of core disciplines.	1	0	0
30.	Certification is a bad idea because it would stifle innovation, limit participation, and force program homogeneity.	1	-1	-4
26.	The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.	1	3	0
29.	Environmental programs cannot be client-based because is difficult to identify just who is a client.	0	-5	-4
1.	Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.	0	-4	4
31.	Defining core competencies will have the effect of drawing a wall around the environmental field, which will adversely affect program flexibility, inclusiveness, and participation.	0	-1	-5

Table 45 Factor A distinguishing statements (continued)

Item	Statement	Placement A	Placement B	Placement C
8.	There is a foundation of knowledge and skills that are central to understanding and solving environmental problems. These need to be incorporated into all programs.	0	-2	5
9.	Academics need the reality checks that can be provided by people outside the academy. Those who are the consumers of the talent pool, who seek a valuable educational experience, and who invest in the enterprise of education all have valuable insights.	-1	2	1
22.	It is important to include various clients in program development and planning to stay connected with market employment needs and evolving environmental concerns.	-2	2	0
13.	The student and his/her advisor should determine an individualized curriculum that is most appropriate for that student.	-2	-1	-4
16.	Metadisciplinary training is desirable, but pragmatic issues of administration and disciplinary department relations limit programs to an interdisciplinary or a transdisciplinary approach.	-2	0	0
35.	Client involvement is important for program support and overall success.	-3	1	-1
20.	Environmental education should continue to follow its traditional focus on providing depth in a single discipline.	-4	-5	-2
25.	Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.	-4	-3	3
14.	Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.	-4	-2	1
11.	Undergraduate programs should have a research-based graduate school preparation track and a practical applications-based professional track.	-5	-2	-3
27.	Since there is no single environmental profession, there needs to be individual certifications for each niche.	-5	-3	-2

Figure 15. Factor B common sort

					2					
				13	10	4				
			7	30	15	6	9			
		23	8	31	16	24	17	26		
	1	25	14	36	32	35	18	39	3	
20	28	27	11	45	42	37	22	40	5	19
29	47	38	21	46	43	44	33	41	12	34
-5	-4	-3	-2	-1	0	1	2	3	4	5

Table 46. Factor B descending z-score array

Item	Statement	Z-score
34.	It is essential for students to understand the interface between nature and social systems—how societies impact the environment and how the environment impacts societies.	2.121
19.	One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.	1.988
3.	Environmental issues inherently transcend traditional disciplinary boundaries; therefore, environmental education should address problems in a way that goes beyond disciplinary thinking.	1.789

Table 46. Factor B descending z-score array (continued)

Item	Statement	Z-score
12.	Systems understanding, recognition of emergent properties, synthesized knowledge, and "thinking outside the box" are important goals of environmental education.	1.463
5.	Students must understand the human contexts—cultural, historical, philosophical, and ethical—of environmental issues.	1.434
40.	It is important for students to gain an understanding of environmental conflicts between competing interests, such as utilitarian versus preservationist, individual versus public, local versus global, and current versus future generations.	1.231
26.	The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.	1.158
39.	Students need to understand the limits of scientific studies and learn to appreciate, quantify, and accurately report uncertainties.	1.102
41.	It is important that all students have exposure to a broad range of subjects, including the humanities and the natural, social, and applied sciences.	1.084
9.	Academics need the reality checks that can be provided by people outside the academy. Those who are the consumers of the talent pool, who seek a valuable educational experience, and who invest in the enterprise of education all have valuable insights.	0.966
17.	Students need to understand how economic policies can damage the environment or be used as tools for solving environmental problems.	0.921
18.	All students should have knowledge of the advantages and limits of technological fixes to environmental problems.	0.704
22.	It is important to include various clients in program development and planning to stay connected with market employment needs and evolving environmental concerns.	0.451
33.	Environmental decisions should be made rationally. Students should learn decision theory techniques such as benefit/cost analysis, risk analysis or other optimization strategies.	0.416
35.	Client involvement is important for program support and overall success.	0.402
24.	Because of the youth of the field and its interdisciplinary nature, core competencies for environmental programs should be sufficiently broad to encompass a variety of different approaches.	0.395
4.	Programs need to be somewhat tailored to the strengths of a given institution.	0.310
44.	Graduate programs should include both a professional non -thesis track and a research-based thesis track.	0.194
37.	Undergraduate preparation for graduate school or an immediate career should be the same to prepare students for life-long learning and critical thinking.	0.166
6.	All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.	0.139
43.	Hard boundaries limit the perspectives that can be brought to bear on environmental problems, which require interdisciplinary solutions.	0.090
32.	Students need to understand business language and paradigms because of the importance of economic considerations in environmental decision-making.	0.079
2.	The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.	0.001
15.	At the undergraduate level, curricula should emphasize basic understanding of a breadth of core disciplines.	-0.011
42.	Program boundaries should be clear enough to demarcate the center from the periphery, but the edges should be fuzzy.	-0.065

Table 46. Factor B descending z-score array (continued)

Item	Statement	Z-score
10.	Certification would be appropriate for some environment professions, but not others.	-0.146
16.	Metadisciplinary training is desirable, but pragmatic issues of administration and disciplinary department relations limit programs to an interdisciplinary or a transdisciplinary approach.	-0.184
13.	The student and his/her advisor should determine an individualized curriculum that is most appropriate for that student.	-0.207
45.	The environmental profession is still evolving and its too early to develop highly defined boundaries.	-0.312
31.	Defining core competencies will have the effect of drawing a wall around the environmental field, which will adversely affect program flexibility, inclusiveness, and participation.	-0.376
30.	Certification is a bad idea because it would stifle innovation, limit participation, and force program homogeneity.	-0.401
46.	The goal of environmental programs should be to be inclusive of anyone who wants to participate, and to avoid walls.	-0.436
36.	At the graduate level, curricula should focus on more specialized areas.	-0.447
21.	Core competencies should be defined broadly—more broadly than any single student could master—and students asked to demonstrate mastery of a subset.	-0.686
7.	Traditional disciplinary programs have developed core competencies; environmental programs should do the same.	-0.763
14.	Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.	-0.774
8.	There is a foundation of knowledge and skills that are central to understanding and solving environmental problems. These need to be incorporated into all programs.	-0.806
11.	Undergraduate programs should have a research-based graduate school preparation track and a practical applications-based professional track.	-0.888
23.	Core competencies are essential for professional certification and perhaps future program accreditation.	-0.983
25.	Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.	-1.048
27.	Since there is no single environmental profession, there needs to be individual certifications for each niche.	-1.066
38.	Client interests are not always compatible with academic goals. It's the faculty's prerogative to develop curricula, not the clients.	-1.117
47.	Program boundaries are important to avoid unnecessary turf wars with other majors and programs.	-1.221
28.	Undergraduate students directly entering the workforce need more breadth, while those preparing for graduate school need more depth.	-1.244
1.	Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.	-1.355
29.	Environmental programs cannot be client-based because is difficult to identify just who is a client.	-1.760
20.	Environmental education should continue to follow its traditional focus on providing depth in a single discipline.	-2.309

Table 47. Factor B distinguishing statements
(20 items distinguish factor B from other factors)

Item	Statement	Placement A	B	C
34.	It is essential for students to understand the interface between nature and social systems—how societies impact the environment and how the environment impacts societies.	4	5	4
12.	Systems understanding, recognition of emergent properties, synthesized knowledge, and "thinking outside the box" are important goals of environmental education.	2	4	1
26.	The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.	1	3	0
9.	Academics need the reality checks that can be provided by people outside the academy. Those who are the consumers of the talent pool, who seek a valuable educational experience, and who invest in the enterprise of education all have valuable insights.	-1	2	1
22.	It is important to include various clients in program development and planning to stay connected with market employment needs and evolving environmental concerns.	-2	2	0
35.	Client involvement is important for program support and overall success.	-3	1	-1
4.	Programs need to be somewhat tailored to the strengths of a given institution.	3	1	2
44.	Graduate programs should include both a professional non -thesis track and a research-based thesis track.	-1	1	-1
6.	All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.	4	1	5
2.	The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.	2	0	-3
10.	Certification would be appropriate for some environment professions, but not others.	-3	0	-2
13.	The student and his/her advisor should determine an individualized curriculum that is most appropriate for that student.	-2	-1	-4
31.	Defining core competencies will have the effect of drawing a wall around the environmental field, which will adversely affect program flexibility, inclusiveness, and participation.	0	-1	-5
30.	Certification is a bad idea because it would stifle innovation, limit participation, and force program homogeneity.	1	-1	-4
36.	At the graduate level, curricula should focus on more specialized areas.	1	-1	2
14.	Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.	-4	-2	1
8.	There is a foundation of knowledge and skills that are central to understanding and solving environmental problems. These need to be incorporated into all programs.	0	-2	5
25.	Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.	-4	-3	3
1.	Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.	0	-4	4
20.	Environmental education should continue to follow its traditional focus on providing depth in a single discipline.	-4	-5	-2

Figure 16. Factor C common sort

					15					
				24	16	5				
			10	32	21	9	3			
		2	20	35	22	12	4	7		
	13	11	27	42	26	14	17	18	1	
31	29	28	38	43	37	23	36	25	19	5
46	30	45	47	44	40	33	41	39	34	8
-5	-4	-3	-2	-1	0	1	2	3	4	5

Table 48. Factor C descending z-score array

Item	Statement	Z-score
6.	All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.	1.856
8.	There is a foundation of knowledge and skills that are central to understanding and solving environmental problems. These need to be incorporated into all programs.	1.680
34.	It is essential for students to understand the interface between nature and social systems—how societies impact the environment and how the environment impacts societies.	1.489
1.	Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.	1.289
19.	One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.	1.223
7.	Traditional disciplinary programs have developed core competencies; environmental programs should do the same.	1.152
25.	Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.	1.044
39.	Students need to understand the limits of scientific studies and learn to appreciate, quantify, and accurately report uncertainties.	1.038
18.	All students should have knowledge of the advantages and limits of technological fixes to environmental problems.	0.991
3.	Environmental issues inherently transcend traditional disciplinary boundaries; therefore, environmental education should address problems in a way that goes beyond disciplinary thinking.	0.990
4.	Programs need to be somewhat tailored to the strengths of a given institution.	0.912
36.	At the graduate level, curricula should focus on more specialized areas.	0.902
17.	Students need to understand how economic policies can damage the environment or be used as tools for solving environmental problems.	0.802
41.	It is important that all students have exposure to a broad range of subjects, including the humanities and the natural, social, and applied sciences.	0.788
33.	Environmental decisions should be made rationally. Students should learn decision theory techniques such as benefit/cost analysis, risk analysis or other optimization strategies.	0.676
5.	Students must understand the human contexts—cultural, historical, philosophical, and ethical—of environmental issues.	0.604
23.	Core competencies are essential for professional certification and perhaps future program accreditation.	0.469

Table 48. Factor C descending z-score array (continued)

Item	Statement	Z-score
12.	Systems understanding, recognition of emergent properties, synthesized knowledge, and "thinking outside the box" are important goals of environmental education.	0.459
14.	Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.	0.397
9.	Academics need the reality checks that can be provided by people outside the academy. Those who are the consumers of the talent pool, who seek a valuable educational experience, and who invest in the enterprise of education all have valuable insights.	0.337
40.	It is important for students to gain an understanding of environmental conflicts between competing interests, such as utilitarian versus preservationist, individual versus public, local versus global, and current versus future generations.	0.146
16.	Metadisciplinary training is desirable, but pragmatic issues of administration and disciplinary department relations limit programs to an interdisciplinary or a transdisciplinary approach.	0.079
22.	It is important to include various clients in program development and planning to stay connected with market employment needs and evolving environmental concerns.	-0.045
37.	Undergraduate preparation for graduate school or an immediate career should be the same to prepare students for life-long learning and critical thinking.	-0.079
21.	Core competencies should be defined broadly—more broadly than any single student could master—and students asked to demonstrate mastery of a subset.	-0.088
15.	At the undergraduate level, curricula should emphasize basic understanding of a breadth of core disciplines.	-0.109
26.	The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.	-0.174
32.	Students need to understand business language and paradigms because of the importance of economic considerations in environmental decision-making.	-0.189
42.	Program boundaries should be clear enough to demarcate the center from the periphery, but the edges should be fuzzy.	-0.247
35.	Client involvement is important for program support and overall success.	-0.302
44.	Graduate programs should include both a professional non-thesis track and a research-based thesis track.	-0.404
24.	Because of the youth of the field and its interdisciplinary nature, core competencies for environmental programs should be sufficiently broad to encompass a variety of different approaches.	-0.440
43.	Hard boundaries limit the perspectives that can be brought to bear on environmental problems, which require interdisciplinary solutions.	-0.529
10.	Certification would be appropriate for some environment professions, but not others.	-0.684
27.	Since there is no single environmental profession, there needs to be individual certifications for each niche.	-0.702
20.	Environmental education should continue to follow its traditional focus on providing depth in a single discipline.	-0.718
47.	Program boundaries are important to avoid unnecessary turf wars with other majors and programs.	-0.721
38.	Client interests are not always compatible with academic goals. It's the faculty's prerogative to develop curricula, not the clients.	-0.742
2.	The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.	-0.816
28.	Undergraduate students directly entering the workforce need more breadth, while those preparing for graduate school need more depth.	-0.866
11.	Undergraduate programs should have a research-based graduate school preparation track and a practical applications-based professional track.	-1.272

Table 48. Factor C descending z-score array (continued)

Item	Statement	Z-score
45.	The environmental profession is still evolving and it's too early to develop highly defined boundaries.	-1.347
29.	Environmental programs cannot be client-based because is difficult to identify just who is a client.	-1.404
30.	Certification is a bad idea because it would stifle innovation, limit participation, and force program homogeneity.	-1.474
13.	The student and his/her advisor should determine an individualized curriculum that is most appropriate for that student.	-1.689
46.	The goal of environmental programs should be to be inclusive of anyone who wants to participate, and to avoid walls.	-2.027
31.	Defining core competencies will have the effect of drawing a wall around the environmental field, which will adversely affect program flexibility, inclusiveness, and participation.	-2.259

Table 49. Factor C distinguishing statements
(25 items distinguish factor C from other factors)

Item	Statement	Placement		
		A	B	C
6.	All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.	4	1	5
8.	There is a foundation of knowledge and skills that are central to understanding and solving environmental problems. These need to be incorporated into all programs.	0	-2	5
1.	Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.	0	-4	4
19.	One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.	4	5	4
7.	Traditional disciplinary programs have developed core competencies; environmental programs should do the same.	-1	-2	3
25.	Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.	-4	-3	3
3.	Environmental issues inherently transcend traditional disciplinary boundaries; therefore, environmental education should address problems in a way that goes beyond disciplinary thinking.	5	4	2
5.	Students must understand the human contexts—cultural, historical, philosophical, and ethical—of environmental issues.	5	4	1
23.	Core competencies are essential for professional certification and perhaps future program accreditation.	-3	-3	1
14.	Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.	-4	-2	1
9.	Academics need the reality checks that can be provided by people outside the academy. Those who are the consumers of the talent pool, who seek a valuable educational experience, and who invest in the enterprise of education all have valuable insights.	-1	2	1

Table 49. Factor C distinguishing statements (continued)

Item	Statement	Placement A	B	C
40.	It is important for students to gain an understanding of environmental conflicts between competing interests, such as utilitarian versus preservationist, individual versus public, local versus global, and current versus future generations.	3	3	0
22.	It is important to include various clients in program development and planning to stay connected with market employment needs and evolving environmental concerns.	-2	2	0
26.	The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.	1	3	0
35.	Client involvement is important for program support and overall success.	-3	1	-1
24.	Because of the youth of the field and its interdisciplinary nature, core competencies for environmental programs should be sufficiently broad to encompass a variety of different approaches.	0	1	-1
43.	Hard boundaries limit the perspectives that can be brought to bear on environmental problems, which require interdisciplinary solutions.	1	0	-1
20.	Environmental education should continue to follow its traditional focus on providing depth in a single discipline.	-4	-5	-2
47.	Program boundaries are important to avoid unnecessary turf wars with other majors and programs.	-3	-4	-2
2.	The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.	2	0	-3
45.	The environmental profession is still evolving and its too early to develop highly defined boundaries.	-1	-1	-3
30.	Certification is a bad idea because it would stifle innovation, limit participation, and force program homogeneity.	1	-1	-4
13.	The student and his/her advisor should determine an individualized curriculum that is most appropriate for that student.	-2	-1	-4
46.	The goal of environmental programs should be to be inclusive of anyone who wants to participate, and to avoid walls.	-2	-1	-5
31.	Defining core competencies will have the effect of drawing a wall around the environmental field, which will adversely affect program flexibility, inclusiveness, and participation.	0	-1	-5

Table 50. Rotation to A/B: factor extraction results

Factor	A′	B′	C	Total
Explained Variance	32%	7%	14%	53%

Table 51. Rotation to A/B: factor correlations

Factor	A′	B′	C
A′	0	.12	.43
B′	.12	0	.18
C	.43	.18	0
Reliabilities	99	92	98
Std. Errors	9	28	15

Table 52. Rotation to A/B: factor loads

Participant	A′	B′	C
1	.80*	-.07	.12
2	.53*	.34	.48*
3	.78*	.25	.21
4	.18	-.24	.54*
5	.82*	.11	.06
6	.59*	-.43	-.03
7	.23	.11	.50*
8	.53*	.09	.34
9	.80*	.25	-.05
10	.66*	-.31	.34
11	.43	.60*	.31
12	.32	-.13	.74*
13	.60*	.40	.19
14	.24	.17	.45*
15	.69*	.19	.32
16	.71*	-.12	.34
17	-.02	.01	.79*
18	.58*	-.39	.13
19	.83*	-.05	.09
20	.53*	-.10	.44
21	.40	.04	.43
22	.71*	-.10	.06
23	.33	.53*	.18
24	.62*	.27	.20
25	.83*	-.19	-.11
26	.49*	.14	.53*
27	.64*	.31	.34
28	.12	-.05	.75*
29	.48*	.32	.11
30	.21	.31	.66*
31	.75*	.02	-.17
32	.58*	-.26	.06
33	.47*	-.20	.35
34	.67*	.17	-.33
35	.37	-.17	.25
36	.55*	.06	.30
37	.42	-.63*	.13
38	.67*	.25	.02
39	-.03	-.06	.54*
40	.65*	.10	-.31
41	.40	-.25	.29
42	.24	-.12	.78*
43	.58*	-.33	.22
44	.83*	-.23	.18

* Denote loadings significant at 0.451, at p<0.001

Table 53. Rotation to A/B: non-significant loaders
(N=3)

Participant	A′	B′	C
21	.40	.43	.04
35	.37	.25	-.17
41	.40	.29	-.25

Table 54. Rotation to A/B: statement scores

Item	Statement	Placement A′	B′	C
1.	Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.	-2	-5	4
2.	The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.	2	0	-2
3.	Environmental issues inherently transcend traditional disciplinary boundaries; therefore, environmental education should address problems in a way that goes beyond disciplinary thinking.	5	1	3
4.	Programs need to be somewhat tailored to the strengths of a given institution.	2	-3	2
5.	Students must understand the human contexts—cultural, historical, philosophical, and ethical—of environmental issues.	4	-1	1
6.	All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.	2	-2	5
7.	Traditional disciplinary programs have developed core competencies; environmental programs should do the same.	-3	-1	3
8.	There is a foundation of knowledge and skills that are central to understanding and solving environmental problems. These need to be incorporated into all programs.	-1	-2	5
9.	Academics need the reality checks that can be provided by people outside the academy. Those who are the consumers of the talent pool, who seek a valuable educational experience, and who invest in the enterprise of education all have valuable insights.	0	5	1
10.	Certification would be appropriate for some environment professions, but not others.	-1	3	-2
11.	Undergraduate programs should have a research-based graduate school preparation track and a practical applications-based professional track.	-5	1	-3
12.	Systems understanding, recognition of emergent properties, synthesized knowledge, and "thinking outside the box" are important goals of environmental education.	3	3	1
13.	The student and his/her advisor should determine an individualized curriculum that is most appropriate for that student.	-2	-1	-4
14.	Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.	-3	2	1
15.	At the undergraduate level, curricula should emphasize basic understanding of a breadth of core disciplines.	1	-3	0
16.	Metadisciplinary training is desirable, but pragmatic issues of administration and disciplinary department relations limit programs to an interdisciplinary or a transdisciplinary approach.	-1	0	0
17.	Students need to understand how economic policies can damage the environment or be used as tools for solving environmental problems.	3	-2	2
18.	All students should have knowledge of the advantages and limits of technological fixes to environmental problems.	2	0	3

Table 54. Rotation to A/B: statement scores (continued)

Item	Statement	Placement A′	B′	C
19.	One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.	5	2	4
20.	Environmental education should continue to follow its traditional focus on providing depth in a single discipline.	-5	-4	-3
21.	Core competencies should be defined broadly—more broadly than any single student could master—and students asked to demonstrate mastery of a subset.	-2	1	0
22.	It is important to include various clients in program development and planning to stay connected with market employment needs and evolving environmental concerns.	0	2	0
23.	Core competencies are essential for professional certification and perhaps future program accreditation.	-3	3	1
24.	Because of the youth of the field and its interdisciplinary nature, core competencies for environmental programs should be sufficiently broad to encompass a variety of different approaches.	1	4	-1
25.	Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.	-4	5	3
26.	The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.	1	4	-1
27.	Since there is no single environmental profession, there needs to be individual certifications for each niche.	-4	1	-2
28.	Undergraduate students directly entering the workforce need more breadth, while those preparing for graduate school need more depth.	-3	-3	-3
29.	Environmental programs cannot be client-based because is difficult to identify just who is a client.	-2	-4	-4
30.	Certification is a bad idea because it would stifle innovation, limit participation, and force program homogeneity.	0	-5	-4
31.	Defining core competencies will have the effect of drawing a wall around the environmental field, which will adversely affect program flexibility, inclusiveness, and participation.	0	-4	-5
32.	Students need to understand business language and paradigms because of the importance of economic considerations in environmental decision-making.	0	-1	-1
33.	Environmental decisions should be made rationally. Students should learn decision theory techniques such as benefit/cost analysis, risk analysis or other optimization strategies.	1	0	1
34.	It is essential for students to understand the interface between nature and social systems—how societies impact the environment and how the environment impacts societies.	4	4	4
35.	Client involvement is important for program support and overall success.	-1	3	0
36.	At the graduate level, curricula should focus on more specialized areas.	1	-2	2
37.	Undergraduate preparation for graduate school or an immediate career should be the same to prepare students for life-long learning and critical thinking.	2	-2	0
38.	Client interests are not always compatible with academic goals. It's the faculty's prerogative to develop curricula, not the clients.	0	-3	-2

Table 54. Rotation to A/B: statement scores (continued)

Item	Statement	Placement A′	B′	C
39.	Students need to understand the limits of scientific studies and learn to appreciate, quantify, and accurately report uncertainties.	3	1	2
40.	It is important for students to gain an understanding of environmental conflicts between competing interests, such as utilitarian versus preservationist, individual versus public, local versus global, and current versus future generations.	3	1	0
41.	It is important that all students have exposure to a broad range of subjects, including the humanities and the natural, social, and applied sciences.	4	1	2
42.	Program boundaries should be clear enough to demarcate the center from the periphery, but the edges should be fuzzy.	-1	0	-1
43.	Hard boundaries limit the perspectives that can be brought to bear on environmental problems, which require interdisciplinary solutions.	1	-1	-1
44.	Graduate programs should include both a professional non-thesis track and a research-based thesis track.	0	2	-1
45.	The environmental profession is still evolving and its too early to develop highly defined boundaries.	-1	-1	-3
46.	The goal of environmental programs should be to be inclusive of anyone who wants to participate, and to avoid walls.	-2	0	-5
47.	Program boundaries are important to avoid unnecessary turf wars with other majors and programs.	-4	0	-2

Table 55. Rotation to A/B: consensus statements
(within 1 unit)

Item	Statement	Placement A′	B′	C
34.	It is essential for students to understand the interface between nature and social systems—how societies impact the environment and how the environment impacts societies.	4	4	4
33.	Environmental decisions should be made rationally. Students should learn decision theory techniques such as benefit/cost analysis, risk analysis or other optimization strategies.	1	0	1
16.	Metadisciplinary training is desirable, but pragmatic issues of administration and disciplinary department relations limit programs to an interdisciplinary or a transdisciplinary approach.	-1	0	0
32.	Students need to understand business language and paradigms because of the importance of economic considerations in environmental decision-making.	0	-1	-1
42.	Program boundaries should be clear enough to demarcate the center from the periphery, but the edges should be fuzzy.	-1	0	-1
28.	Undergraduate students directly entering the workforce need more breadth, while those preparing for graduate school need more depth.	-3	-3	-3

Figure 17. Factor A′ common sort

					9					
				8	22	15				
			1	10	30	24	2			
		7	13	16	31	26	4	12		
	25	14	21	35	32	33	6	17	5	
11	27	23	29	42	38	36	18	39	34	3
20	47	28	46	45	44	43	37	40	41	19
-5	-4	-3	-2	-1	0	1	2	3	4	5

Table 56. Factor A′ descending z-score array

Item	Statement	Z-score
3.	Environmental issues inherently transcend traditional disciplinary boundaries; therefore, environmental education should address problems in a way that goes beyond disciplinary thinking.	1.912
19.	One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.	1.841
34.	It is essential for students to understand the interface between nature and social systems—how societies impact the environment and how the environment impacts societies.	1.826
5.	Students must understand the human contexts—cultural, historical, philosophical, and ethical—of environmental issues.	1.787
41.	It is important that all students have exposure to a broad range of subjects, including the humanities and the natural, social, and applied sciences.	1.188
17.	Students need to understand how economic policies can damage the environment or be used as tools for solving environmental problems.	1.145
40.	It is important for students to gain an understanding of environmental conflicts between competing interests, such as utilitarian versus preservationist, individual versus public, local versus global, and current versus future generations.	1.134
12.	Systems understanding, recognition of emergent properties, synthesized knowledge, and "thinking outside the box" are important goals of environmental education.	1.025
39.	Students need to understand the limits of scientific studies and learn to appreciate, quantify, and accurately report uncertainties.	0.917
18.	All students should have knowledge of the advantages and limits of technological fixes to environmental problems.	0.877
4.	Programs need to be somewhat tailored to the strengths of a given institution.	0.781
6.	All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.	0.716
37.	Undergraduate preparation for graduate school or an immediate career should be the same to prepare students for life-long learning and critical thinking.	0.678
2.	The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.	0.625
43.	Hard boundaries limit the perspectives that can be brought to bear on environmental problems, which require interdisciplinary solutions.	0.611
26.	The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.	0.559

Table 56. Factor A′ descending z-score array (continued)

Item	Statement	Z-score
24.	Because of the youth of the field and its interdisciplinary nature, core competencies for environmental programs should be sufficiently broad to encompass a variety of different approaches.	0.428
33.	Environmental decisions should be made rationally. Students should learn decision theory techniques such as benefit/cost analysis, risk analysis or other optimization strategies.	0.345
15.	At the undergraduate level, curricula should emphasize basic understanding of a breadth of core disciplines.	0.303
36.	At the graduate level, curricula should focus on more specialized areas.	0.173
30.	Certification is a bad idea because it would stifle innovation, limit participation, and force program homogeneity.	0.158
32.	Students need to understand business language and paradigms because of the importance of economic considerations in environmental decision-making.	0.060
9.	Academics need the reality checks that can be provided by people outside the academy. Those who are the consumers of the talent pool, who seek a valuable educational experience, and who invest in the enterprise of education all have valuable insights.	0.055
38.	Client interests are not always compatible with academic goals. It's the faculty's prerogative to develop curricula, not the clients.	0.026
31.	Defining core competencies will have the effect of drawing a wall around the environmental field, which will adversely affect program flexibility, inclusiveness, and participation.	-0.015
44.	Graduate programs should include both a professional non-thesis track and a research-based thesis track.	-0.196
22.	It is important to include various clients in program development and planning to stay connected with market employment needs and evolving environmental concerns.	-0.205
42.	Program boundaries should be clear enough to demarcate the center from the periphery, but the edges should be fuzzy.	-0.289
45.	The environmental profession is still evolving and its too early to develop highly defined boundaries.	-0.317
16.	Metadisciplinary training is desirable, but pragmatic issues of administration and disciplinary department relations limit programs to an interdisciplinary or a transdisciplinary approach.	-0.400
10.	Certification would be appropriate for some environment professions, but not others.	-0.455
8.	There is a foundation of knowledge and skills that are central to understanding and solving environmental problems. These need to be incorporated into all programs.	-0.461
35.	Client involvement is important for program support and overall success.	-0.569
21.	Core competencies should be defined broadly—more broadly than any single student could master—and students asked to demonstrate mastery of a subset.	-0.573
13.	The student and his/her advisor should determine an individualized curriculum that is most appropriate for that student.	-0.690
46.	The goal of environmental programs should be to be inclusive of anyone who wants to participate, and to avoid walls.	-0.696
29.	Environmental programs cannot be client-based because is difficult to identify just who is a client.	-0.716
1.	Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.	-0.831
7.	Traditional disciplinary programs have developed core competencies; environmental programs should do the same.	-0.874
23.	Core competencies are essential for professional certification and perhaps future program accreditation.	-1.013

Table 56. Factor A′ descending z-score array (continued)

Item	Statement	Z-score
28.	Undergraduate students directly entering the workforce need more breadth, while those preparing for graduate school need more depth.	-1.351
14.	Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.	-1.413
47.	Program boundaries are important to avoid unnecessary turf wars with other majors and programs.	-1.488
25.	Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.	-1.503
27.	Since there is no single environmental profession, there needs to be individual certifications for each niche.	-1.518
11.	Undergraduate programs should have a research-based graduate school preparation track and a practical applications-based professional track.	-1.562
20.	Environmental education should continue to follow its traditional focus on providing depth in a single discipline.	-2.038

Table 56. Factor A′ distinguishing statements
(28 items distinguish factor A′ from other factors)

		Placement		
Item	Statement	A′	B′	C
3.	Environmental issues inherently transcend traditional disciplinary boundaries; therefore, environmental education should address problems in a way that goes beyond disciplinary thinking.	5	1	3
19.	One needs to understand that environmental problems are also social/political problems in order to arrive at socially relevant, politically real, and economically viable solutions.	5	2	4
5.	Students must understand the human contexts—cultural, historical, philosophical, and ethical—of environmental issues.	4	-1	1
41.	It is important that all students have exposure to a broad range of subjects, including the humanities and the natural, social, and applied sciences.	4	1	2
6.	All environmental students must be comfortable with interpreting scientific information and engaging in scientific discourse.	2	-2	5
37.	Undergraduate preparation for graduate school or an immediate career should be the same to prepare students for life-long learning and critical thinking.	2	-2	0
2.	The most important thing is for students to understand environmental issues from a broad perspective rather than training them for a specific professional career.	2	0	-2
43.	Hard boundaries limit the perspectives that can be brought to bear on environmental problems, which require interdisciplinary solutions.	1	-1	-1
26.	The environmental field is constantly changing. Flexibility is the key to keep environmental programs responsive and relevant.	1	4	-1
24.	Because of the youth of the field and its interdisciplinary nature, core competencies for environmental programs should be sufficiently broad to encompass a variety of different approaches.	1	4	-1
15.	At the undergraduate level, curricula should emphasize basic understanding of a breadth of core disciplines.	1	-3	0
36.	At the graduate level, curricula should focus on more specialized areas.	1	-2	2
30.	Certification is a bad idea because it would stifle innovation, limit participation, and force program homogeneity.	0	-5	-4
38.	Client interests are not always compatible with academic goals. It's the faculty's prerogative to develop curricula, not the clients.	0	-3	-2

Table 56. Factor A′ distinguishing statements (continued)

Item	Statement	Placement A′	B′	C
31.	Defining core competencies will have the effect of drawing a wall around the environmental field, which will adversely affect program flexibility, inclusiveness, and participation.	0	-4	-5
16.	Metadisciplinary training is desirable, but pragmatic issues of administration and disciplinary department relations limit programs to an interdisciplinary or a transdisciplinary approach.	-1	0	0
35.	Client involvement is important for program support and overall success.	-1	3	0
21.	Core competencies should be defined broadly—more broadly than any single student could master—and students asked to demonstrate mastery of a subset.	-2	1	0
46.	The goal of environmental programs should be to be inclusive of anyone who wants to participate, and to avoid walls.	-2	0	-5
29.	Environmental programs cannot be client-based because is difficult to identify just who is a client.	-2	-4	-4
1.	Deep strength in a given discipline is required for a student to make original, creative, and important contributions to any field.	-2	-5	4
7.	Traditional disciplinary programs have developed core competencies; environmental programs should do the same.	-3	-1	3
23.	Core competencies are essential for professional certification and perhaps future program accreditation.	-3	3	1
14.	Program boundaries will establish the environmental profession as a respected and legitimate profession, and clarify expectations for students and employers.	-3	2	1
47.	Program boundaries are important to avoid unnecessary turf wars with other majors and programs.	-4	0	-2
25.	Defining a core curriculum will legitimize the environmental profession, define program boundaries for students, and clarify expectations for employers.	-4	5	3
27.	Since there is no single environmental profession, there needs to be individual certifications for each niche.	-4	1	-2
11.	Undergraduate programs should have a research-based graduate school preparation track and a practical applications-based professional track.	-5	1	-3

APPENDIX F – PHASE II SURVEY DESIGN

Sample Size. The survey population included all programs meeting the selection criteria (census sample instead of a random sample) due to the relatively low number of programs (840) and the desire to obtain an optimally comprehensive database of program information for ongoing study.

Choice of Survey Method. A self-administered web-based questionnaire was chosen as the data collection method for several reasons: (1) the convenience of the respondents, (2) cost considerations, and (3) error reduction.

Personal interviews and telephone interview methods were rejected because the 840 targeted survey respondents reside across the United States, making these methods impractical and prohibitively expensive. In addition, the survey is quite long, requiring an hour or more to complete, and requires information that may not be immediately available. These aspects, along with the very busy and varied schedules of the targeted respondents, made telephone interviews unfeasible.

A web-based survey was specifically chosen for the self-administered questionnaire based on: (1) the expense of printing and mailing the survey and follow-up reminders to 840 respondents, (2) the convenience of allowing the respondents to complete the survey in as many online sessions as they desired and of allowing others (such as program assistants) to enter information, (3) the ability to program the questions to reduce entry errors and automatically code data, and (4) the ease of transferring data from the online database to statistical software packages for analysis. Another consideration was that web-based questionnaires have been shown to elicit higher response rates that mail surveys (Cobanoglu et al. 2001).

Self-administered questionnaires have advantages and disadvantages. Bias is not introduced by an interviewer, but an interviewer is not immediately available to clarify the meaning of the questions if a respondent is unsure what is being asked. For this survey, respondents were encouraged to contact the researcher with any questions and several did, either by telephone or email. Question wording is very important in self-administered questionnaires to ensure clarity and to avoid introducing bias via ambiguous or leading questions. Extensive vetting and pilot testing of the survey by a panel of experts comprised of environmental program administrators was used to minimize these potential problems.

Web-based surveys also reduce errors because backend programming can eliminate respondents' entry mistakes (such as choosing more than one answer when only one is desired) and facilitate automatic coding (which reduces coding errors). Email distribution of the pre-notification, request for participation, and reminder messages costs are negligible, but programming and secure web hosting costs can be substantial, depending upon the desired parameters of the survey. In this case, programming and hosting services were provided by a sponsor (the lead researchers' husband) so these costs were not a consideration. The main disadvantage of a web-based survey is in introducing bias through a typically much lower response rate compared to personal or telephone interviewing.

Questionnaire Design. The web-based questionnaire included four broad groups of questions: institution information, program administrator information, program information, and degree program information (See Appendix A for the complete questionnaire). The first group of questions, institution information, was pre-entered by the researcher into each survey and was not completed by the respondents. This included institution name, location (city/state), and Carnegie classification information. The researcher also pre-entered the name, title and contact information of the program administrator (respondent), the name of the program, and the names, types (BS, BA, etc.), and specializations for the interdisciplinary environmental degrees awarded by the program. This information, along with the institution name and location, was visible to the respondent upon log-in, who was asked to review the information and make any required changes.

Pre-entering the program administrators' titles and contact information, program names, degrees, and host institution information reduced the amount of information requested from the respondents and enabled the researcher to ensure that each survey was properly assigned to a respondent (program) and recorded in the online database. It also allowed for quality control in that each respondent could see which program and degrees were included in the survey. This was important attribute of the survey for degree programs located within departments or other administrative units that offered other types of degrees and programs not included in the survey.

The respondent web-based questionnaire was divided into eight sections (web pages) to make it easier to navigate: (1) institution, administrator and basic program information (pre-entered), (2) list of degrees for the survey (pre-entered), (3) program administrator questions, (4-6) program questions I, II and III, (7) degree questions (for each degree), and (8) curricular emphases questions (for each degree). Each respondent was able to move through the survey in any sequence and could enter and leave the survey as often as desired; in addition respondents were not required to answer every question since some questions would not apply to all programs. Given the length of the survey, the researcher decided it was best to enable the respondents to review and complete the survey however they wished. The trade-off was the possibility of incomplete surveys, which did occur in a few cases although it is impossible to tell if the respondent accidentally or intentionally submitted an incomplete survey.

The program administrator questions inquired into the nature of the administrator's appointment, formal training, professional society memberships, and gender. The program information questions included questions about program characteristics, resources, and the factors that influence program design and evolution. The degree related questions included degree requirements, curricular emphases placed on knowledge and skills areas, and student and graduate demographics.

Three types of questions were used in the questionnaire: open-ended, closed-form multiple choice and asymmetric Likert scale rankings. The majority of questions were designed to elicit a single response (multiple choice or Likert scale) to reduce the time needed to complete the survey, reduce errors (these questions were programmed to allow only one answer) and to facilitate automatic coding. Many of the multiple choice questions included an "other" option with a space to type in a short answer to ensure respondents' answers weren't artificially constrained by the available choices. A few questions were included to capture demographic information (e.g., average number of degree program graduates) or to capture detailed information and elicit the full range of perspectives and views regarding certain questions (e.g., distinguishing features of the program).

The majority of the questions requested factual information and were ordered in a logical sequence. Two sets of questions requested the opinions of the respondents (influences on various factors on program success, and importance of various knowledge and skill areas for degree graduates). These questions took the form of asymmetrical Likert scales and were grouped by category (e.g., employment factors, or social science knowledge areas). Grouping the questions into categories may have influenced rankings (see post facto critique for a discussion).

The questionnaire website was designed to look professional and to maximize ease of use. Questions were divided into sections to reduce scrolling and to reduce the number of questions per web-page. The survey was quite long so it was important to break the questions into sections to reduce the perceived length of the survey and to make the survey easier to complete. Colors were kept neutral with white backgrounds, accents where matched to the logos for CEDD/NCSE, and an easily readable web font was chosen.

Each targeted respondent was assigned a survey number in the online database which contained the pre-entered information. A log-in system was utilized so that each respondent entered the survey via a user name consisting of her/his email address and a password that consisted of her/his first name followed by a sequence of 3 randomly assigned numbers (the user name and password were included in the request for participation and all reminders). When a respondent entered the survey she/he entered the menu page. This page included directions for reviewing the pre-entered information and navigating the survey. The first time a respondent clicked on a link to a section of the questionnaire they were required to read and agree to the consent form; consent was recorded in the survey database. The consent form did not appear again as the respondent navigated through or re-entered the survey. A link was provided on the menu page for respondents to exit the program without submitting to CEDD and a link to submit the survey when completed.

The length of the survey was substantial (8 program administrator questions, 22 program questions, and 20 questions for each degree, and 1 question about the survey). In general, longer surveys are expected to have lower response rates, leading the researchers and CEDD advisors to extensively consider and debate the survey length. In the end, the longer survey was agreed upon based on the purpose and nature of the survey project. The survey was conducted for CEDD/NCSE, a large national organization, which desired a database with a large amount of baseline information for ongoing study. In addition, the survey is the first comprehensive survey of U.S. environmental program characteristics, curricula structure and design, and the research project is exploratory in nature; existing curricular models, trends and influencing factors are unknown.

The questions were designed and included based upon the environmental education literature, the objectives of the project, and on an understanding of the structure and characteristics of environmental programs. The survey length did appear to significantly affect response rates. Although pilot testing of the survey elicited only one comment about the survey length, 18% of those who entered the survey did not complete (submit) the survey.

Questionnaire Review and Pretest. The questionnaire was initially created in January 2007 by the primary researcher, reviewed several times by the research team (including a survey expert), CEDD members and CEDD/NCSE staff, and finally tested with a beta test survey of CEDD members in October 2007. The research team conducted three rounds of assessment, the CEDD Curriculum Committee and CEDD/NCSE staff participated in two rounds of assessment, and a forum was conducted at the CEDD 2007 summer meeting where the questionnaire was discussed with the CEDD membership. Numerous changes were made in the number and content of the questions, question wording, and question order based upon this extensive review process.

After the web survey site and database was built and tested a test survey using a convenience sample of volunteer CEDD members was conducted in October 2007. Seventeen CEDD members completed the survey and provided feedback. The majority of the changes made as a result of the test were adjustments to the survey questions to accommodate the widely varying structure and design of interdisciplinary programs. In addition, a final question was added that asked the respondents to explain any difficulties they encountered answering the questions due to the nature of their program, or to include additional important information about their program that was not elicited by the questions. The data provided by the seventeen testers was retained and they were asked to review their answers during the survey period to make any necessary adjustments due to changes made in the survey instrument.

IRB approval was obtained prior to the pretest and again following the changes made in response to the feedback from the testers. A copy of the final survey, cover letter and reminders is included at end of the proposal in Appendix A.

Pre-notification, Request to Participate (Cover Letter) and Reminders. The survey included a pre-notification email alerting targeted respondents that they would be receiving a request to participate in the survey, a cover letter requesting participation, and three follow-up email reminders (see Appendix C for the text of the messages). In addition, individualized contacts were made with CEDD members via email and phone to request their assistance in increasing the response rate by encouraging their colleagues to participate. These messages were delivered by CEDD/NCSE staff, the researcher, and other CEDD members.

The research team decided to launch the survey in early January 2008 to give program administrators the opportunity to participate prior to the beginning of the spring semester. Program administrators are typically especially busy with end of semester/quarter/year responsibilities and the holidays during November and December. The initial pre-notification email went out the first Monday after Christmas and the survey request for participation approximately a week later in January. The three reminders were sent on a monthly basis in February, March and April, with the last two extending the deadlines for completing the survey. The first reminder was sent two weeks before the first deadline (March 1st). The second reminder was sent a few days after the initial deadline had passed and the third after the extended deadline (April 15th) had passed. The survey was officially closed May 15th.

Several attributes of the request for participation were designed to maximize the response rate. All emails (pre-notification, request for participation, reminders) were sent from NCSE rather than from the researcher and were signed by the Executive Secretary of CEDD, the CEDD Curriculum Committee Chair, and the researcher. An incentive (an advance copy of the report) was promised to those completing the survey, and the importance of the survey for the environmental field and CEDD/NCSE was stressed. Confidentiality was assured for sensitive elements of the survey. Advance notices of the survey were included in the CEDD newsletter and list serve postings. All reminder emails included the number of program administrators who had already completed the surveys and emphasized the importance of the program administrators' participation for the success of the survey.

Survey Response. A total of 263 program administrators submitted their surveys as complete, although not all submitted surveys were actually complete. Some respondents either accidentally or intentionally left some questions unanswered. This was especially true for the degree-related questions, perhaps because some respondents were confused by how to switch from one degree to another in the survey website. Following data screening, three programs were removed from the study because the types of the degrees they awarded did not fit the survey criteria (see data screening below). Another 22 degree programs were deleted from the survey because they did not fit the survey criteria or were duplicates. The programs awarding these degrees were retained because other degrees they awarded did fit the survey criteria.

The overall response rate was 31%; representing 260 program leaders at 238 institutions offering 343 IE degrees.

All 260 surveys were used for analysis with the number of responses reported for each question/item analyzed. Baccalaureate degrees comprised 73% of the total number of degrees included in the survey, master's degrees 20%, and doctoral degrees 7%. These percentages are somewhat skewed toward undergraduate degrees; the proportions of degree levels in the data collected for all target programs were 68% baccalaureate degrees, 22% masters degrees and 10% doctoral degrees. It is not known if this census data is entirely accurate however, since these programs did not participate in the survey and degree programs change over time (Also see the representativeness of the sample discussion below).

The non-response included 8 hard refusals, 56 who accessed the survey but did not complete or submit (only completed very few questions or none at all after entering), and 516 who did not access the survey at all.

Statistical Validity. Calculations where performed to determine an optimal response rate for statistical validity for measuring attributes (proportion of population) using the following equation and values:

d = 5% = .05 (margin of error)

α = 95% = .05 = 1.96

p = .5 most conservative since no range data

$$n = \frac{z^2 p(1-p)}{d^2} = \frac{1.96^2(.25)}{.05^2} = 384$$

With finite population correction for programs

$$n = \frac{384}{1 + \frac{384}{840}} = 264$$

With finite population correction for degree programs

$$n = \frac{384}{1 + \frac{384}{1183}} = 290$$

Data Screening. The information provided for three programs and 26 degree programs were deleted from the analysis because they did not meet the survey selection criteria. The programs deleted were: QID 2572 – Agricultural Education degree only; QID 2583 – Environmental Health, Safety and Occupational Management degrees only; and QID 3275 – Biology degree only. The following degree programs were deleted:

- Agricultural Education (QID 2572)
- Biology BS (2) (QID 3093, 3275)
- Building Materials and Wood Technology BS (QID 2717)
- Concentration for Childhood Education Majors and Minor (2) (QID 3221)
- Duplicate Degree – Environmental Science and Policy BS (QID 3235)
- Ecology BS (QID 2740)
- Engineering and Public Policy Masters (QID 3119)
- Environmental and Natural Resource Economics MS, PhD (QID 2486)
- Environmental Biology BS (2) (QID 2782, 3075)
- Environmental Chemistry BS (QID 2782)
- Environmental Geology BS (QID 2782)
- Environmental Health Bachelors (QID 3205)
- Environmental Health, Safety and Occupational Management BS (QID 2583)

- Environmental Safety and Health Management BS, MS (QID 2583)
- Forestry BS (QID 2717)
- Occupational and Environmental Health and Safety MS (QID 3192)
- Resource Economics and Commerce BS (QID 2486)
- Water Resources Engineering PhD (QID 3126)
- Wildlife and Fisheries Conservation BS, MS, PhD (QID 2717)
- Wildlife and Conservation Biology BS (QID 3062)

The responses to each question were also screened for accuracy and outliers and either corrected or deleted from the statistical analysis database (SPSS version 17) based upon the discrepancy discovered.

*Results. T*he survey collected a total of 378 variables (e.g., number of students in the program, yes/no checkbox answers, multiple choice answers) and text answers (e.g., text entered into short answer fields, text entered into “other” fields, and answers to open-ended questions). The survey data includes 18 variables/answers pre-entered (primarily institution information, including Carnegie classification), 35 for each program administrator, 189 for each program, 58 for each degree, and 78 for curricular emphases.

Data from the online survey database was downloaded into Excel spreadsheets, screened, coded and imported into SPSS version 17 software for analysis. The survey data is divided into two sets, one for programs (260) and one for degrees (343). Since a program can have more than one associated degree, directly comparing program attributes and degree attributes requires coding each attribute from one data set to another.

APPENDIX G – PHASE II SURVEY QUESTIONNAIRE

Note: The survey was conducted via a web survey so its appearance is somewhat different than depicted below (e.g. the spaces for answers are text boxes of various sizes).

Pre-Entered Institution, Program, Degrees and Administrator Data (access restricted to researcher)

1. Institution name: _________________________________
2. Institution city:____________________________________
3. Institution state: [dropdown box with state two-letter codes]
4. Basic Carnegie classification:
   - ❍ RU/VH: Research Universities (very high research activity)
   - ❍ RU/H: Research Universities (high research activity)
   - ❍ DRU: Doctoral/Research Universities
   - ❍ Master's/L: Master's Colleges and Universities (larger programs)
   - ❍ Master's/M: Master's Colleges and Universities (medium programs)
   - ❍ Master's/S: Master's Colleges and Universities (small programs)
   - ❍ Bac/A&S: Baccalaureate Colleges – Arts and Sciences
   - ❍ Bac/Diverse: Baccalaureate Colleges – Diverse Fields
   - ❍ Tribal Colleges
   - ❍ Other
5. Control (primary source of funding):
   - ❍ Public
   - ❍ Private, not-for-profit
   - ❍ Private, for-profit
6. Student enrollment:
   - ❍ VS: Very small (< 1,000 FTE degree-seeking students)
   - ❍ S: Small (1,000-2,999 FTE degree-seeking students)
   - ❍ M: Medium (3,000-9,999 FTE degree-seeking students)
   - ❍ L: Large (10,000+ FTE degree-seeking students)
7. Undergraduate student residency status:
   - ❍ NR: Primarily nonresidential (<25% of UG degree-seeking students live on campus, includes exclusively distance institutions)
   - ❍ R: Primarily residential (25-49% of UG degree-seeking students live on campus)
   - ❍ HR: Highly residential (≥ 50% of UG degree-seeking students live on campus)
8. Enrollment profile:
   - ❍ ExU: Exclusively undergraduate
   - ❍ VHU: Very high undergraduate (graduate/professional students less than 10% of FTE enrollment)
   - ❍ HU: High undergraduate (graduate/professional students between 10-24% of FTE enrollment)
   - ❍ MU: Majority undergraduate (graduate/professional students between 25-49% of FTE enrollment)
   - ❍ MGP: Majority graduate/professional (graduate/professional students at least 50% of FTE enrollment)
   - ❍ ExGP: Exclusively graduate/professional

9. Program name: ____

10. Program administrator name: ___________________________________

11. Program Administrator Title: ____________________________________

12. Title category:

    - ❍ Dean/Assistant Dean/Associate Dean
    - ❍ School Director/Chair/Head
    - ❍ Program Director/Manager/Coordinator
    - ❍ Department Chair/Head
    - ❍ Other (identify):

13. Administrator email address:

14. Administrator business telephone:

For each interdisciplinary environmental degree awarded by the program:

15. Degree name:____

16. Degree level: [dropdown box: bachelor of science, bachelor of arts, other bachelor's, master of science, master of arts, other master's, doctor of philosophy, other doctoral]

17. Degree category: [dropdown box: environmental science(s); environmental studies; natural resource management; policy planning and administration; other]

18. Degree specializations:____

Login

National Census Survey of U.S. Higher Education Environmental Degree Programs

Council of Environmental Deans and Directors, National Council for Science and the Environment

This survey comprises Phase II of an ongoing curriculum study conducted by the Curriculum Committee of the Council of Environmental Deans and Directors (CEDD). The survey project has four objectives: 1) develop an understanding of the curricular content and design of existing higher education IEprograms, (2) determine the different types of curriculum models that exist, (3) identify influences and trends in curricula evolution, and (4) determine relationships that exist between program and institutional characteristics and curricular content and design.

The program administrator is the desired respondent for the survey and is the only individual qualified to answer many of the questions. If you are not this individual, please forward the information about the survey to her/him.

The survey will take approximately an hour to complete, depending upon how many degrees your program offers that meet the survey criteria. The survey does not need to be completed in a single session, you may exit and enter as needed and other may assist.

Your participation is important and appreciated! Enter the User Name and Password provided in the email you received to begin the survey.

User Name: Password:

Contact Shirley Vincent at shirley.vincent@okstate.edu or 918-629-5143 if you have any questions about or problems with the survey.

Menu

Menu

This menu will help guide you through the different sections of the survey. Some information about you (program administrator) and your program have been pre-entered into the survey database. Please review the *Program Administrator/Program Information* and the *List of Degrees and Specializations* and edit as needed before continuing.

The first time you enter a section of the survey you will be prompted to give your informed consent and confirm your willingness to participate. Please read the informed consent statement and indicate your consent with the *Consent* button. The consent prompt will not appear again.

The survey is divided into six sections. At the top of each section are links to the *Menu* and the next section. It will be easiest to begin with the *Program Administrator Questions* and proceed sequentially from there but you may navigate to any section in any order by returning to the *Menu* page. You may exit the survey at any time by using the *Exit Survey* link on the *Menu* page. Once you have completed answering all the questions, submit the survey to CEDD using the *Notify CEDD I've Completed the Survey* link.

CAUTION: So not use your browser's back button! Please use the links at the top of the pages to navigate through the survey. Remember to save your answers before exiting each section and before taking a break from the survey. The survey session will time out after 45 minutes of inactivity and require you to log-in again. You will lose any unsaved answers.

1) Program Administrator/Program Information
2) List of Degrees and Specializations
3) Program Administrator Questions
4) Program Questions: Part I
5) Program Questions: Part II
6) Program Questions: Part III
7) Degree Questions (for each degree)
8) Curricular Emphases (for each degree)
9) Exit Survey
10) Notify CEDD I've Completed the Survey

Informed Consent

Menu

Informed Consent Statement

Before proceeding, you must read the Informed Consent Statement and confirm your willingness to participate. You are being asked to participate in this research project because you administer a degree-granting (baccalaureate or above) environmental program that focuses holistically on the human and natural systems interface from a broad interdisciplinary perspective.

The survey comprises part of a larger ongoing study conducted by the Council of Environmental Deans and Directors (CEDD) of the National Council for Science and the Environment (NCSE). The objectives of the survey are:

1. develop an understanding of the curricular content and design of existing higher education interdisciplinary environmental programs,
2. determine the different types of curriculum models that exist,
3. identify influences and trends in curricula evolution, and
4. determine the relationships that exist between program and institutional characteristics and curricular content and design.

The overall goal of the research project is to strengthen the identity and improve the quality of environmental programs by elucidating core competencies for program graduates, determining criteria for evaluating program success, and identifying effective curriculum design models.

Upon your consent, you will be directed to the online survey questionnaire that is divided into six sections. The first section, *Program Administrator Information*, includes questions about you, the nature of your appointment as program administrator, your formal training and the professional societies in which you are most active. The second through fourth sections, *Program Information*, includes questions about your program's demographics, available resources, and factors that influence program design and change. The fifth and sixth sections, *Degree Information and Curricular Emphases*, includes questions about each degree (and specializations within each degree) offered by your program. These questions include student and graduate demographics, degree requirements, and curricular emphases placed on various knowledge and skills areas.

Your answers will be kept confidential and will be released only as summaries in which no individual's answers can be associated with the respondent. Only aggregate survey results will be presented in a publicly available report published by the NCSE/CEDD in 2008.

Survey responses will be stored in a professionally-managed secure database accessible only by members of the research team. The data will be downloaded onto researchers' computers for analysis and protected using standard security procedures. All response data will be destroyed after five years.

This research is part of an effort conducted by Shirley Vincent, a doctoral student at Oklahoma State University, and directed by Dr. Will Focht, Director of the Environmental Institute and Environmental Science Graduate program at Oklahoma State University. The study is being funded by the National Council for Science and the Environment. If you have any questions, you may contact Dr. Focht at 003 Life Sciences East, Stillwater, OK 74078; telephone number (405) 744-9994. You may also contact Dr. Sue C. Jacobs, IRB Chair, Oklahoma State University, 219 Cordell North, Stillwater, OK 74078; telephone number (405) 744-1676 or irb@okstate.edu.

It is important that you understand the following guidelines:

- Your participation in this research is entirely voluntary. You may quit at any time.
- Any sensitive information we collect in the survey will be held in strict confidence.
- The factual demographic information collected in the survey about your program will be made available to the public.

Please indicate your willingness to participate in this research by checking the I Consent box. Doing so confirms that you have read and understand this consent form and that you freely and voluntarily agree to participate in the survey.

❑ I have read the statement and give my consent.

Program Administrator/Program Information

Menu   Continue to List of Degrees and Specializations

Review the information below and make any necessary changes. If the institution or program listed is not correct, please call or email Shirley Vincent at 918-629-5143 or shirley.vincent@okstate.edu.

First Name: Last Name:

Title: Title Category

Email Address: Business Phone:

Institution Name: Program Name:

Edit

List of Degrees and Specializations

Menu   Continue to Program Administrator Questions

Review the list of degrees below and the specializations listed for each. If the information about a degree is incorrect, delete the degree (you will need to delete any specializations associated with the degree first – go to the View/Add Specializations) and renter the degree using the Add Degree tool. You may also add a new degree or another degree offered by your program you believe should be included in the survey (see note below).

The target population for the survey is baccalaureate and graduate degree programs in the U. S, that focus on the interface of human and natural systems from an interdisciplinary perspective. This includes all environmental science and environmental studies programs and well as some programs with other names. If you have questions about the degrees listed or about degrees to add to the list, please contact Shirley Vincent at 918-629-5143 or Shirley.vincent@okstate.edu.

View/Add Specializations   Degree Name   Degree Type   Delete Degree

Add Degree Tool

Enter the degree name: Select the degree type: (dropdown box listing BA, BS, Other Baccalaureate, MA, MS, Other Masters, and PhD)

Add Degree

To edit a degree, first delete the specializations and the degree and renter the information.

Program Administrator Questions

Program Administrator Questions

Menu   Continue to Program Questions: Part I

1. What is your gender?

   - Female
   - Male

2. What is the nature of your appointment as the/a program administrator?

- ❍ I am the sole administrator of this program and have a full-time appointment.
- ❍ I am the sole administrator of this program but employed only part-time as the administrator.
- ❍ I co-administer the program but I have a full-time appointment as the administrator.
- ❍ I co-administer this program and have a part-time appointment.
- ❍ The program does <u>not</u> have an <u>official</u> administrator.
- ❍ Other (explain):______________________________

3. If you are a part-time administrator, what percentage of your time (percent of FTE) is dedicated to administering the program?___%

4. How long have you served as program administrator? Round up to nearest academic year: _____years

5. If the program administrator is a rotating position, how long does an individual serve? _____years

6. What is your faculty rank?

- ❍ Professor
- ❍ Associate Professor
- ❍ Assistant Professor
- ❍ Instructor
- ❍ Adjunct
- ❍ Non-faculty appointment
- ❍ Other (identify): ______________________________________

7. Please provide information about your academic training (degrees earned and field(s) of study). Separate fields of study within the same degree category with a semicolon.

- ❑ BA in: ____
- ❑ BS in: ____
- ❑ Other baccalaureate: ________________________________

- ❑ MA in: ____
- ❑ MS in: ____
- ❑ Other master's: ____________________________________

- ❑ PhD in: ____
- ❑ Other doctoral: ____________________________________

- ❑ MBA, specializing in: _______________________________
- ❑ Law (name of degree): ______________________________
- ❑ Medical (name of degree): ___________________________
- ❑ Other professional degree: ___________________________

- ❑ Other degree: ______________________________________

8. In which professional societies (of which you are a member) most closely correspond with your professional interests? List up to three:__________________________

Program Questions: Part I

Menu Continue to Program Questions: Part II

1. Please check the program types(s) and enter the date(s) established as a degree-granting entity. The program boxes must be checked for the program dates to be recorded).

- ❑ Undergraduate program Date established: __________
- ❑ Graduate program Date established: __________

2. If your program (undergraduate, graduate or both) was established in or before 1982 (25+ years in existence), answer this question to help us determine trends and influences in program curriculum design. If your program was established after 1982, skip to question 3.

   Please briefly summarize the most significant factors that have influenced your program's success over time, such as changes in curriculum (core requirements, degrees offered, focus), program goals, guiding ideology, program funding, administrative location within the university, external or internal influences, etc.: ____

3. What primary factor(s) led to the establishment of the program? Check all that apply.

   Undergraduate program

   - ❑ Student demand
   - ❑ Employer demand/employment opportunities
   - ❑ Faculty initiative
   - ❑ Administration initiative
   - ❑ Response to local/regional environmental concerns
   - ❑ Response to national/global environmental concerns
   - ❑ Viewed as essential to the mission of the institution
   - ❑ Private donation(s)/endowment
   - ❑ Unknown
   - ❑ Other (identify): _______________________________________

   Graduate program

   - ❑ Student demand
   - ❑ Employer demand/employment opportunities
   - ❑ Faculty initiative
   - ❑ Administration initiative
   - ❑ Response to local/regional environmental concerns
   - ❑ Response to national/global environmental concerns
   - ❑ Viewed as essential to the mission of the institution
   - ❑ Private donation(s)/endowment
   - ❑ Unknown
   - ❑ Other (identify): _______________________________________

4. Where in the institutional hierarchy is the program located? Check only one.

   - ❍ The program is located within a consortium of one or more institutions (e.g., Environmental Science Program operated by the Colleges of the Fenway Consortium). Name: ____
   - ❍ The program is located within an independent environmental institute, center or other institution-level academic unit (e.g., Environmental Science program within the Graduate College; Environmental Studies program within the Environmental Institute). Name:__________
   - ❍ The program is located within two or more secondary-level academic unit (colleges, schools, divisions) (e.g., Environmental Studies program operated by the College of Arts and Sciences and the College of Agriculture). Name: ____
   - ❍ The program is located within a secondary-level academic unit (college, school, division) but not within any department (e.g., Natural Resources program located within the College of Agriculture). Name: ____
   - ❍ The program is located within its own secondary-level academic unit (college, school, division). (e.g., School of Environmental Studies). Name: ____

- ❍ The program is located within two or more departments (e.g., Environmental Science program operated by the Biology and Earth Sciences Departments). Name: ________________________
- ❍ The program is located within a department as a component of a larger department (e.g., Environmental Science program within the Department of Biological Sciences). Name: ____
- ❍ The program is located in its own department (e.g., Department of Environmental Studies in the College of Natural Sciences). Name: ____

5. Please provide information about the program faculty (estimated). Answer all that apply and enter 0 where appropriate.

   Number of endowed chairs or professorships in the program: ______

   Number of faculty with full-time (tenure-track or contractual) appointments in the program: _______

   Number of faculty with part-time appointments (e.g. adjunct and joint appointments or time bought) in the program: _______

   Of those with part-time appointments, how many are primarily employed outside the college/university: ______

   Number of faculty who voluntarily support the program (teaching program courses, serving on the program advisory board and/or directing student research): ______

6. Select the answer below that best corresponds to your program's dedicated budget in relation to programs or departments with similar numbers of enrolled majors.

   Undergraduate program

   - ❍ Much less than other programs/departments
   - ❍ Less than other programs/departments
   - ❍ Equivalent to other programs/departments
   - ❍ Greater than other programs/departments
   - ❍ Much greater than other programs/departments
   - ❍ Program does not have a dedicated budget
   - ❍ Unsure

   Graduate program

   - ❍ Much less than other programs/departments
   - ❍ Less than other programs/departments
   - ❍ Equivalent to other programs/departments
   - ❍ Greater than other programs/departments
   - ❍ Much greater than other programs/departments
   - ❍ Program does not have a dedicated budget
   - ❍ Unsure

7. Identify the percentage of the program's funding that comes from the following sources. Percentages should add to 100Complete all boxes and enter 0 where appropriate

   Percent from non-directed funds (appropriations, tuition and fees, etc.): ______

   Percent from long-term directed funds (endowments, facilities, etc.): _______

   Percent from short-term directed funds (grants, contracts, earmarks, gifts, etc.): ______

8. Which variables are measured for program assessment? Check all that apply.

- ❑ Student satisfaction
- ❑ Alumni satisfaction
- ❑ Faculty satisfaction
- ❑ Graduate job placement
- ❑ Program graduation rates
- ❑ Student scholarship (awards, publications, presentations)
- ❑ Student portfolios
- ❑ External program review
- ❑ Internal program review
- ❑ Other (list): ___________________________________

9. Which formal guidelines, if any, have been used in designing the program curricula? Check all that apply.

- ❑ North American Association for Environmental Education National Guidelines for Environmental Education (2006)
- ❑ Inventory for Assessing Environmental Curricula (Kim 2003, revised from Gardella 1986)
- ❑ Association for the Advancement of Sustainability in Higher Education Leadership Workshops (2006-07)
- ❑ National Survey of Student Engagement and American Association for Higher Education Project Documenting Effective Educational Practice (2006)
- ❑ No formal guidelines

❑ Other (identify): ____

10. How do students, alumni, employers, and other constituents provide feedback in the design/implementation of the program curriculum? Check all that apply.

- ❑ Student surveys
- ❑ Student exit interviews
- ❑ Student advisory boards
- ❑ Employer surveys
- ❑ Alumni surveys
- ❑ External advisory board
- ❑ Other (explain):____

11. How would you judge the average level of student/program faculty interaction?

Undergraduate

- ❑ Very High
- ❑ High
- ❑ Moderate
- ❑ Low
- ❑ Minimal

Graduate

- ❑ Very High
- ❑ High
- ❑ Moderate
- ❑ Low
- ❑ Minimal

12. How would you judge the average level of student/program staff interaction?

Undergraduate

- ❑ Very High
- ❑ High
- ❑ Moderate
- ❑ Low
- ❑ Minimal

Graduate

- ❑ Very High
- ❑ High
- ❑ Moderate
- ❑ Low
- ❑ Minimal

13. How would you judge the average level of program student/student interaction?

Undergraduate

- ❑ Very High
- ❑ High
- ❑ Moderate
- ❑ Low
- ❑ Minimal

Graduate

- ❑ Very High
- ❑ High
- ❑ Moderate
- ❑ Low
- ❑ Minimal

Program Questions: Part II

Menu   Continue to Program Questions: Part III

14. Does your institution have one or more centers or institutes dedicated to environmental or sustainability education, research or outreach? Check all that apply

- ❑ No
- ❑ Yes, focused on environmental education
- ❑ Yes, focused on environmental research
- ❑ Yes, focused on environmental outreach
- ❑ Yes, focused on sustainability education
- ❑ Yes, focused on sustainability research
- ❑ Yes, focused on sustainability outreach
- ❑ Yes, other focus (explain):____

15. Indicate which types of environmental/sustainability facilities are available for use by program students and faculty. Check all that apply

- ❑ Specialized laboratory(ies)
- ❑ Specialized computer laboratory(ies) (e.g. GIS, modeling software)
- ❑ Field station(s) or campus
- ❑ Nature center(s) or protected area(s)
- ❑ Other facilities (list):____

16. Indicate which types of **program-specific** funding and other resources are available for use by program students and faculty. Check all that apply.

- ❑ Student scholarships/fellowships
- ❑ Student research grants
- ❑ Student travel support
- ❑ Faculty research grants
- ❑ Faculty teaching/course development support
- ❑ Faculty travel support
- ❑ Support for outreach
- ❑ External learning opportunities (e.g. internships, service learning, community-based learning, etc.)
- ❑ Student teaching, research and/or service awards
- ❑ Faculty teaching, research and /or service awards
- ❑ Other funding/resources (list):____

17. Indicate which types of external resources (e.g., formal affiliations or partnerships) are utilized in the program curricula. Check all that apply. Note: The external resources type boxes **MUST BE CHECKED** for the corresponding resource names entered to be recorded in the survey database.

- ❑ Other higher education institutions within the U.S. (including university partnerships, consortia, specialized training programs). List names and locations (city/state): ____
- ❑ Higher education institutions outside the U.S. List names and locations (city/country): ____
- ❑ Independent research institutes and laboratories (U.S. and international). List names and locations (city/state or city/country): ____
- ❑ Governmental institutions (including planning and policy consortiums or initiatives). List names and locations (city/state): ____
- ❑ Private sector organizations (U.S. and international). List names and locations (city/state or city/country): ____
- ❑ Non-government environmental organizations (U.S. and international). List names and locations (city/state or city/country): ____

18. Indicate how students and faculty utilize the external resources listed in question 17 above. Check all that apply.

Undergraduate

- ❑ Students participate in education programs
- ❑ Students participate in research programs
- ❑ Students participate in service learning/outreach programs
- ❑ Students participate in field/internships/applied learning experiences
- ❑ Faculty participate in education programs
- ❑ Faculty participate in research programs
- ❑ Faculty participate in service learning/outreach programs
- ❑ Faculty participate in field/internships/applied learning experiences
- ❑ Other (describe): ____

Graduate

- ❑ Students participate in education programs
- ❑ Students participate in research programs
- ❑ Students participate in service learning/outreach programs
- ❑ Students participate in field/internships/applied learning experiences
- ❑ Faculty participate in education programs
- ❑ Faculty participate in research programs
- ❑ Faculty participate in service learning/outreach programs
- ❑ Faculty participate in field/internships/applied learning experiences
- ❑ Other (describe): ____

19. Briefly describe any features that you believe distinguish your program from other environmental programs at higher education institutions, including, but not limited to initiatives related to minority/diversity enhancement, high school partnerships, and career preparation: ____

20. If your program has recently undergone or is undergoing a significant change, please explain (e.g. change in program name, location within the administrative hierarchy, merging of programs, change in mission/objectives, change in number and type of degrees or specializations): ____

Program Questions: Part III

Menu Continue to Degree Questions

21. The following question is designed to learn more about the influences on your program's success. For each factor listed indicate: (1) the magnitude of the factor's influence, and (2) your degree of satisfaction with how the factor has contributed to your program's success.

FACTOR	MAGNITUDE OF INFLUENCE				DEGREE OF SATISFACTION			
	LOW	MODERATE	HIGH	NONE/NA	LOW	MODERATE	HIGH	NONE/NA
INSTITUTION FACTORS								
Institutional support (resources)	❍	❍	❍	❍	❍	❍	❍	❍
Program location within administrative hierarchy	❍	❍	❍	❍	❍	❍	❍	❍
Program leadership	❍	❍	❍	❍	❍	❍	❍	❍
Faculty support	❍	❍	❍	❍	❍	❍	❍	❍
Competition with other programs, departments, or units	❍	❍	❍	❍	❍	❍	❍	❍

FACTOR	MAGNITUDE OF INFLUENCE				DEGREE OF SATISFACTION			
	LOW	MODERATE	HIGH	NONE/NA	LOW	MODERATE	HIGH	NONE/NA
EXTERNAL SUPPORT FACTORS								
Federal funding support	❍	❍	❍	❍	❍	❍	❍	❍
State or local government funding support	❍	❍	❍	❍	❍	❍	❍	❍
Foundation or private donor funding support	❍	❍	❍	❍	❍	❍	❍	❍
Public support	❍	❍	❍	❍	❍	❍	❍	❍
Political leaders' support	❍	❍	❍	❍	❍	❍	❍	❍
PARTNERSHIP FACTORS								
U.S. higher education institution partnerships	❍	❍	❍	❍	❍	❍	❍	❍
Foreign higher education institution partnerships	❍	❍	❍	❍	❍	❍	❍	❍
Government agency partnerships	❍	❍	❍	❍	❍	❍	❍	❍
Private sector partnerships	❍	❍	❍	❍	❍	❍	❍	❍
Non-governmental organization partnerships	❍	❍	❍	❍	❍	❍	❍	❍
Professional society partnerships	❍	❍	❍	❍	❍	❍	❍	❍
CURRICULUM FACTORS								
Definition of degrees & specializations	❍	❍	❍	❍	❍	❍	❍	❍
Developing courses	❍	❍	❍	❍	❍	❍	❍	❍
Sequencing courses	❍	❍	❍	❍	❍	❍	❍	❍

FACTOR	MAGNITUDE OF INFLUENCE				DEGREE OF SATISFACTION			
	LOW	MODERATE	HIGH	NONE/NA	LOW	MODERATE	HIGH	NONE/NA
Incorporating real-world problems into courses	❍	❍	❍	❍	❍	❍	❍	❍
GRADUATE EMPLOYMENT FACTORS								
Local/regional employment opportunities	❍	❍	❍	❍	❍	❍	❍	❍
National employment opportunities	❍	❍	❍	❍	❍	❍	❍	❍
International employment opportunities	❍	❍	❍	❍	❍	❍	❍	❍

22. Identify any factors not listed in above and indicate he magnitude of influence and degree of satisfaction for each: ____

Degree Questions (for each degree)

[Menu] [Continue to Curricular Emphasis Questions]

Select a degree from the dropdown box and click the select button. A set of questions for the degree will be displayed. Once you have completed the question and saved your answers, select another degree and complete the set of questions for that degree. Continue until you have answered the same set of questions for each degree listed.

DO NOT USE THE BACK BUTTON ON THIS PAGE!

List of Degrees in dropdown box   Select Degree

You are answering questions about: Degree name, Degree type

1. Estimated average annual student enrollment (over last 5 years or since inception if less than 5 years): ________students

2. Estimated average annual number of graduates (over last 5 years or since inception if less than 5 years): ________graduates

3. Estimated average annual number of racial/ethnic minority American students enrolled in the degree program (over last 5 years or since inception if less than 5 years): ________students

4. Estimated average annual number of foreign students enrolled in the degree program (over last 5 years or since inception if less than 5 years): ________students

5. How has student enrollment changed over the last five years?

   ❍ Rapid growth
   ❍ Slow growth
   ❍ No growth
   ❍ Slow decline
   ❍ Rapid decline

6. Do you limit the number of students admitted to the degree program each year?

    - ❍ Yes, due to limited number of slots available
    - ❍ Yes, due to qualifications of applicants
    - ❍ Yes, due to limited number of slots and qualifications of candidates
    - ❍ No

7. What are the objectives of this degree program?

    - ❑ Prepare students for environmental careers
    - ❑ Prepare students for entry into graduate/professional programs
    - ❑ Prepare students to become environmental academics
    - ❑ Prepare students to be active environmental leaders/change agents
    - ❑ Provide general environmental awareness and literacy for all students
    - ❑ Advance environmental/sustainability research
    - ❑ Improve environmental policy decision-making
    - ❑ Provide service to the community/region through service learning/applied research/outreach
    - ❑ Other (specify): ____

8. How has this degree program changed significantly over the last five years? Check all that apply.

    - ❑ Curriculum. Describe the change: ____
    - ❑ Faculty. Describe the change:____
    - ❑ Funding support. Describe the change:____
    - ❑ Partnerships. Describe the change: ____
    - ❑ Student enrollment. Describe the change: ____
    - ❑ Other. Describe the change: ____

9. Which description most closely matches the design of the curriculum for this degree?

    - ❍ Depth in a particular disciplinary area (e.g., applied sciences, physical sciences, life sciences, social sciences)
    - ❍ Focus on a particular environmental theme (e.g., watershed management, biodiversity, environmental policy, sustainability)
    - ❍ Broad exposure to a wide range of environmental topics
    - ❍ Multiple options with different core requirements
    - ❍ Multiple options with universal core requirements
    - ❍ Other (explain): ____

10. Does the degree program include sustainability/sustainable science/sustainable development? Check all that apply.

    - ❑ Sustainability is a core principle
    - ❑ Sustainability in included in required coursework
    - ❑ Sustainability in included in optional coursework
    - ❑ Sustainability is included in research experiences
    - ❑ Sustainability is included in applied or service learning experiences
    - ❑ No, sustainability is not included
    - ❑ Other (specify): ____

11. How many credit hours are required for the degree?

Type:

- ❍ Semester hours
- ❍ Quarter hours

a) Total for degree (bachelors, masters or doctoral w/o master's):_____
   If doctoral degree, total with a master's degree:_____
b) Hours specific to the major (required courses and constrained electives):______

12. Is a formal written research report/thesis/dissertation required? (formal is meant to imply an individual or team research project that includes data analysis).

- ❍ Always required
- ❍ Not required
- ❍ Required in certain cases (explain): ____

13. Is substantial coursework in another major required?

- ❍ Always required
- ❍ Not required
- ❍ Required in certain cases (explain): ____

14. Is participation in a research project required?

- ❍ Always required
- ❍ Not required, but available as an option
- ❍ Not required and not offered
- ❍ Required in certain cases (explain): ____

15. Is a formal external internship required?

- ❍ Always required
- ❍ Not required, but available as an option
- ❍ Not required and not offered
- ❍ Required in certain cases (explain): ____

16. Is a service learning or similar community project required?

- ❍ Always required
- ❍ Not required, but available as an option
- ❍ Not required and not offered
- ❍ Required in certain cases (explain): ____

17. Is participation in a design studio required?

- ❍ Always required
- ❍ Not required, but available as an option
- ❍ Not required and not offered
- ❍ Required in certain cases (explain): ____

18. Is an advanced synthesis (capstone) class required?

- ❍ Always required
- ❍ Not required, but available as an option
- ❍ Not required and not offered
- ❍ Required in certain cases (explain): ____

19. Are there other requirements? (explain):____

Curricular Emphases Questions (for each degree)

Menu

Select a degree from the dropdown box and click the select button. A set of questions for the degree will be displayed. Once you have completed the question and saved your answers, select another degree and complete the set of questions for that degree. Continue until you have answered the same set of questions for each degree listed.

DO NOT USE THE BACK BUTTON ON THIS PAGE!

List of Degrees in dropdown box   Select Degree

You are answering questions about: Degree name, Degree type

20. The following question is design to: (1) determine your opinion on the importance of knowledge and skills competencies for degree program graduates (regardless of how they are obtained; formally or informally), and (2) the emphasis on knowledge and skills areas in this degree program's curriculum. Base your answers on the degree type, the typical student earning the degree, and the required components of the degree (mandatory coursework and constrained electives; exclude general education requirements or other electives). **Please use the variable answer only where the curriculum varies substantially from one student to another**.

Knowledge Area	Importance in Ideal Curriculum				Emphasis in Current Curriculum			
	Low	Mod	High	Min /None	Low	Mod	High	Min /None
Natural Sciences								
Physical sciences: geology, chemistry, physics, hydrology, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Life sciences: biology, zoology, botany, microbiology, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Social Sciences								
Policy and public administration: law and regulation, policy process, policy analysis, organizational theory, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Economics: microeconomics, macroeconomics, econometrics, valuation economics, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Other social sciences: sociology, group behavior, culture, anthropology, psychology, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Humanities								
History: environmental, natural, civilization, cultural, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Philosophy and ethics: ontology, epistemology, logic, values, culture, diversity, etc	❍	❍	❍	❍	❍	❍	❍	❍
Language arts: structure, meaning, metaphor, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Applied								
Engineering and built environment: ecological, civil, chemical, mechanical, building design, landscape design, etc.	❍	❍	❍	❍	❍	❍	❍	❍

Knowledge Area	Importance in Ideal Curriculum				Emphasis in Current Curriculum			
	Low	Mod	High	Min /None	Low	Mod	High	Min /None
Business: management, green business practices, sustainable business, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Education: pedagogy, curriculum design, non-traditional, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Research: approaches, methods, design, ethics, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Interdisciplinary								
Geography: physical, economic, cultural, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Natural resources management and agriculture: forestry, fisheries, wildlife, soils, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Sustainability: management of coupled human and natural systems aimed at long-term satisfaction of quality of life	❍	❍	❍	❍	❍	❍	❍	❍

Skills Area	Importance in Ideal Curriculum				Emphasis in Current Curriculum			
	Low	Mod	High	Min /None	Low	Mod	High	Min /None
Cognitive/Intellectual								
Critical thinking: discernment, type I and II errors, causation versus association, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Problem solving: logic, rational approaches to problems, solution analyses, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Creativity: innovation, iconoclasm, synergism, aesthetics, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Synthesis: systems thinking, inter- and supra-disciplinary integration, complexity, etc	❍	❍	❍	❍	❍	❍	❍	❍
Analysis: reductionism, structure versus function, component studies, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Communication								
Technical and academic writing: specialized writing for technical and scientific reporting	❍	❍	❍	❍	❍	❍	❍	❍
Creative and journalistic writing: specialized writing for specific publishing venues	❍	❍	❍	❍	❍	❍	❍	❍
Oral communication: articulation, confidence, preparation, timing, planning, conditions for ideal speech, etc	❍	❍	❍	❍	❍	❍	❍	❍
Mass communications: media, electronic, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Research								
Literature: library, online, search strategies, abstract preparation, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Field: techniques and practices, instrumentation, data collection, interpretation, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Laboratory: techniques and practices, instrumentation, data collection, interpretation, etc.	❍	❍	❍	❍	❍	❍	❍	❍

Skills Area	Importance in Ideal Curriculum				Emphasis in Current Curriculum			
	Low	Mod	High	Min /None	Low	Mod	High	Min /None
Social: survey design, sampling strategies, data interpretation, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Computational								
Mathematics: algebra, geometry, trigonometry, calculus, matrix algebra, etc	❍	❍	❍	❍	❍	❍	❍	❍
Statistics: probability, uncertainty, measures of central tendency, measures of variance, measures of association, taxonomy, time series, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Spatial analysis: geographic information systems (GIS), remote sensing, interpolation, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Decision science: optimization, criteria identification, modeling	❍	❍	❍	❍	❍	❍	❍	❍
Information management: database structures and analytic protocols, data organization and retrieval, etc	❍	❍	❍	❍	❍	❍	❍	❍
Managerial								
Personnel management: recruitment, training, tasking, evaluation, conflict management, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Project management: budget, time, space, materials, equipment, transportation, purchasing, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Leadership: supervise tasks and teams of people, initiate and implement strategies, motivation, etc.	❍	❍	❍	❍	❍	❍	❍	❍
Community relations: community engagement, collaborative decision-making	❍	❍	❍	❍	❍	❍	❍	❍
Advocacy and outreach: media, policymaker, business leader, and public communications	❍	❍	❍	❍	❍	❍	❍	❍

21. The extreme diversity of higher education interdisciplinary environment programs makes it difficult to develop a survey to fit all possible program structures and designs. Please add any comments about the survey (including any difficulties answering a question or questions because of the nature of your program) and any important information about your program not addressed in the survey:____

Pre-/Notification, Request for Participation, and Reminder Emails

Advance Notification

Subject line: Request for Participation in National Council for Science and the Environment Survey

Dear Dr. [last name],

In a few days, you will receive a request to participate in a survey of administrators of IEprograms at higher education institutions in the United States. The survey is the first attempt to comprehensively examine the curriculum of these programs and is part of an ongoing research effort by Oklahoma State University sponsored by the Council of Environmental Deans and Directors (CEDD) of the National Council for Science and the Environment (NCSE). All participants will receive an advance copy of the results of the survey.

The survey has four objectives: (1) develop an understanding of the curricular content and design of existing higher education IEprograms, (2) determine the different types of curriculum models that exist, (3) identify influences and trends in curricula evolution, and (4) determine relationships that exist between program and institutional characteristics and curricular content and design.

If you have any questions or comments about this study, we would be happy to talk with you. Please call Shirley Vincent at 918-629-5143 or Will Focht at the Oklahoma State Environmental Institute at 405-744-9994. For more information about CEDD and the NCSE visit the website at http://ncseonline.org.

Thank you for your time and attention to our request. It is only with your help that our study can be successful!

Sincerely,

Shirley Vincent, M.S.
Research Associate, Council of Environmental Deans and Directors, National Council for Science and the Environment
Environmental Science Graduate Program, Oklahoma State University

Will Focht, Ph.D.,
Curriculum Committee Chair, Council of Environmental Deans and Directors, National Council for Science and the Environment
Director of the Institute for Sustainable Environments, Oklahoma State University

David Blockstein, Ph.D.
Executive Secretary, Council of Environmental Deans and Directors
Senior Scientist, National Council for Science and the Environment

Request for Participation

Subject line: Request for Participation in National Council for Science and the Environment Survey

Dear Dr. [last name],

We are contacting you to ask for your help in a survey of administrators of IEprograms at higher education institutions in the United States. The survey is the first attempt to comprehensively examine the curricula of these programs. This research is being conducted by Oklahoma State University and is funded by the Council of Environmental Deans and Directors (CEDD) of the National Council for Science and the Environment (NCSE, http://ncseonline.org). All participants will receive an advance copy of the results of the survey.

The survey has four objectives: (1) develop an understanding of the curricular content and design of existing higher education IEprograms, (2) determine the different types of curriculum models that exist, (3) identify influences and trends in curricula evolution, and (4) determine relationships that exist between program and institutional characteristics and curricular content and design.

You were selected to participate in this survey because you administer a degree-granting (baccalaureate or above) environmental program that focuses holistically on the human and natural systems' interface from a broad interdisciplinary perspective. If you disagree that your program has this focus, please contact Shirley Vincent at shirley.vincent@okstate.edu to remove your program from our list.

The survey is designed to facilitate ease of use and minimize completion time. You may enter and exit the survey or have others assist in answering questions as you wish. Anyone entering information into the survey for your program must use the same password, but only one person may be logged-in at any one time.

Institution name: [institution name]
Program name: [program name]
Login ID: [email address]
Survey password: [password]

The survey is available at: http://ceddsurvey.ncseonline.org**. Please complete the survey by March 1st.**

This survey will require approximately an hour to complete. You may others assist you and you do not have to complete the survey in a single session. The survey is voluntary; you may decide not to continue participating at any time. However, your participation is important to help us learn more about IEprograms. If you do not wish to participate, please respond to this email with "remove from study" in the subject line and we will remove you from our list.

If you have any questions or comments about this study, we would be happy to talk with you. Please call Shirley Vincent at 918-629-5143 or Dr. Will Focht at the Oklahoma State Environmental Institute at 405-744-9994. Thank you for your time and attention to our request. It is only with your help that our study can be successful!

Sincerely,

Shirley Vincent, M.S.
Research Associate, Council of Environmental Deans and Directors, National Council for Science and the Environment
Environmental Science Graduate Program, Oklahoma State University

Will Focht, Ph.D.,
Curriculum Committee Chair, Council of Environmental Deans and Directors, National Council for Science and the Environment
Director of the Institute for Sustainable Environments, Oklahoma State University

David Blockstein, Ph.D.
Executive Secretary, Council of Environmental Deans and Directors
Senior Scientist, National Council for Science and the Environment

Reminder (same for all three with number of responses and due dates changed)

Subject line: Request for Participation in National Council for Science and the Environment Survey

Dear Dr. [last name],

About three weeks ago we sent you an email request to participate in a survey of administrators of environmental programs at higher education institutions in the United States. This research is being conducted by Oklahoma State University and is funded by the Council of Environmental Deans and Directors (CEDD) of the National Council for Science and the Environment (NCSE, http://ncseonline.org). All participants will receive a copy of the results of the survey. To the best of our knowledge, you have not yet completed the survey.

XXX of your fellow environmental program administrators have already completed the survey. We are contacting you again because of the importance that your survey has for helping us obtain accurate results. It's only by hearing from nearly everyone that we can be sure the results are truly valid and representative of all IEprograms.

The survey is designed to facilitate ease of use and minimize completion time. You may enter and exit the survey or have others assist in answering questions as you wish. Anyone entering information into the survey for your program must use the same password, but only one person may be logged-in at any one time.

Institution name: [institution name]
Program name: [program name]
Login ID: [email address]
Survey password: [password]

The survey is available at: http://ceddsurvey.ncseonline.org**. Please complete the survey by XXXXX.**

This survey will require about an hour to complete. The survey is voluntary; you may decide not to continue participating at any time. However, your participation is important to help us learn more about IEprograms. If you do not wish to participate, please respond to this email with "remove from study" in the subject line and we will remove you from our list.

Thank you for participating in this important study.

Sincerely,

Shirley Vincent, M.S.
Research Associate, Council of Environmental Deans and Directors, National Council for Science and the Environment
Environmental Science Graduate Program, Oklahoma State University

Will Focht, Ph.D.,
Curriculum Committee Chair, Council of Environmental Deans and Directors, National Council for Science and the Environment
Director of the Institute for Sustainable Environments, Oklahoma State University

David Blockstein, Ph.D.
Executive Secretary, Council of Environmental Deans and Directors
Senior Scientist, National Council for Science and the Environment

Senior Scientist, National Council for Science and the Environment

P.S. If you have any questions, please feel free to contact us. Our numbers are Shirley Vincent at 918-629-5143, Will Focht at the Oklahoma State Environmental Institute at 405-744-9994. Thank you for your time and attention to our request. It is only with your help that our study can be successful!

APPENDIX H –EXPLORATORY FACTOR ANALYSIS PROTOCOL

There are six primary steps in conducting a factor analysis. The first is to determine if the data matrix is suitable for factor analysis, second is choosing an extraction technique, third is choosing a rotation method, fourth is determining how many factors to retain, fifth is interpreting the factors (factor loadings to consider in the interpretation), and sixth is validating the factor structure (Field 2005).

Suitability of the Data Matrices. Several parameters are used to determine if a data matrix is appropriate for factor analysis. All of the parameters were met for both the knowledge and skills data matrices as described below:

- Composition of the data matrix – All the variables to be analyzed must have been administered to all the subjects included in the factor analysis. Prior to the analysis the knowledge and skills rating data were screened for missing values. Cases that were only missing one or two variables were completed by entering the mean for that variable. Cases missing more than two variables were excluded from the analysis as well as obvious outlier cases (such as low or high importance ratings for all knowledge and skills areas). A total of 308 complete knowledge sets and 304 skills sets were obtained for analysis.

- Subjects-to-variables (STV) ratio – A common rule of thumb is ≥ 5 subjects (observations) per variable as a minimum with ≥ 10 optimal. However, as the sample size increases random errors of measurement tend to cancel each other, so for samples over 300 the relation of subjects to variables becomes less important. Arrindell and van der Ende (1985) investigated the stability of factors as a function of STV and concluded neither the STV nor the absolute number of subjects had any effect on factor stability. They argue that the unique definition of an underlying factor depends upon the precision with which the correlation coefficients can be estimated and on the degree of factor over determination (the number of variables in the data set related to each factor). When the number of factors that theoretically would be expected to emerge cannot be estimated, an STV ratio of 5-10 is recommended for samples up to 300 (Tinsley and Tinsley 1987). A recent survey of 303 published principal components or exploratory factor analyses noted that one-sixth were based on STV rations of 2:1 or less (Costello and Osborne 2005). Strict rules have disappeared because several studies have shown that adequate sample size is partly determined by the nature of the data (Costello and Osborne 2005).

  For the purposes of this study knowledge and skills variable sets will be analyzed separately to facilitate interpretation, therefore sample sizes are ≥ 304 if all degrees are analyzed together, ≥ 221 for UG programs only and ≥ 83 for GR programs only. Analyzing all degree programs together and knowledge and skills variable sets separately provides ratios ≥ 13. The ratios for UG programs are ≥ 10, and for GR programs ≥ 4. The study analyzed all degree knowledge sets together (STV=19.3) and all degree skills sets together (STV=13.2), both excellent STV ratios.

- Measures of association – The variables used in the analysis should correlate, but not too highly. The investigator should eliminate any variables that have correlations ≥ .9 and those with no significant correlations. For this study, both the knowledge data matrix and the skills data matrix had no variables with correlations ≥ .9 or no significant correlations so all variables were retained.

  Multicollinearity should be checked using the determinant of the R-matrix (should be ≥ .00001). For this study the determinant was .007 for the knowledge matrix and .0000147 for the skills matrix, so both matrices met this assumption.

  Factor analysis can utilize either the correlation matrix or covariance matrix. The correlation matrix is the default method and must be used when variables are measured on different scales. Correlation coefficients are insensitive to variance in the dispersion and shape of data so in cases where these are deemed important the covariance matrix should be used to produce better-defined factor structures. Variables must be commensurable if the covariance matrix is used. In our case 4 point Likert scales are used so the variables are commensurable and are assumed to have normal distributions. The matrix used is also dependent upon the extraction method chosen. For this study, the correlation matrix was used because of the chosen extraction method and because the rating variables did exhibit normality.

- Significance of the matrix – Bartlett's test of sphericity is used to test if the data matrix contains meaningful information (is not an identity matrix). A significant test is required. Both the knowledge and skills data matrices were highly significant for this test with p=.000.

- Kaiser-Meyer-Olkin measure of sampling adequacy – The KMO is another way to test the data matrix for appropriateness for factor analysis. The KMO value is between 0 and 1 where 0 indicates the sum of partial correlations is large relative to the sum of correlations. This indicates diffusion in the pattern of correlations. A KMO of .5 to .7 is mediocre, between .7 and .8 good, between .8 and .9 great and over .9 superb. The KMO value for the knowledge data matrix was .808 and for the skills matrix .882, both considered excellent.

- Measures of sampling adequacy – anti-image matrix of covariances and correlations contains measures of sampling adequacy along the diagonals. These should all be > .5, if lower, consider dropping from the analysis. All of the variables had measures of sampling adequacy > .5 for both the knowledge and skills data matrices.

Extraction Method Selection. There are several different methods for factor extraction which can be grouped into appropriate uses based on the assumptions the investigator makes about the sample subjects and variables and on whether the analysis is exploratory or hypothesis testing (Tinsley and Tinsley 1987). The first consideration is if the factor analysis may be generalizable to a population. In descriptive methods of factor analysis, the research assumes that the sample of subjects and variables represent the population of interest and generalization of the results is only possible after replication of the analysis on additional populations. Inferential methods permit the researcher to generalize from a sample of subjects to a population of subjects or from a sample of variables to a population of variables. For this study an inferential method was chosen based on assumptions about the sample subjects and variables as described below.

Another important consideration is whether the analysis is exploratory or hypothesis testing. This study is exploratory so exploratory methods are appropriate. Exploratory descriptive methods include principal components analysis which uses all sources of variance—common, unique and error— and principle factor analysis which only includes common variance in the analysis. Principal components analysis is technically a transformation of the data into a set of orthogonal variables rather than a true factor analysis. Principal components analysis is the method of choice when all the variance is to be retained, while principle factors analysis is the preferred method when only the common variance is to be included (Tinsley and Tinsley 1987; Costello and Osborne 2005).

Exploratory inferential methods include canonical analysis and maximum likelihood analysis which both assume the subjects were randomly sampled and the variables constitute the total population of variables. Only one of these methods, maximum likelihood, is available in the SPSS 17.0 statistical software package. Maximum likelihood is recommended for exploratory inferential factor analyses because it includes a statistical goodness-of-fit test (Costello and Osborne 2005).

For the purposes of this study, the maximum likelihood method was chosen for the primary analysis with verification by comparison with the principle factor analysis. The sample of subjects was assumed to be random since the sample met statistical validity criteria and was representative of the study population, and the population of knowledge and skills variables was assumed to constitute the total population since the survey was developed and vetted by numerous experts in the field.

Rotation Method Selection. Rotation is used to simplify and clarify the data structure. This process rotates the factor axes such that variables are loaded maximally to only one factor. Two types of rotations are performed: orthogonal and oblique. Orthogonal rotation rotates factor while keeping them independent while oblique rotation allows the factors to correlate. Oblique rotation is typically used when there is good reason to assume that the factors could be related in theoretical terms. Varimax rotation is the preferred orthogonal method and maximizes the dispersion of loadings within factors. Direct oblimin or Promax are the recommended oblique methods (Field 2005) unless the data set is very large.

Oblique rotations require more complicated explanatory hypotheses because they require explanation of both the latent dimensions underlying each factor and the latent dimensions underlying the correlations among the factors. For the purposes of this study both orthogonal and oblique rotation methods are used and the results compared.

Determining Factors to Retain. Five criteria are considered when determining the number of factors to retain. These criteria are weighed by the investigator when deciding how many factors to interpret.

- Eigenvalue - Kaiser's criterion (Kaiser 1974) recommends retaining all factors with eigenvalues ≥ 1. However, Jolliffe (1986) reports that Kaiser's criterion is too strict and recommends retaining all factors .7 and above). Underestimation of the number of factors is usually a more serious problem than over extraction (Tinsley and Tinsley 1987).

- Scree test - Cantell's scree test is based on the assumption that as a matrix becomes residual, succeeding factors extracted from the matrix represent only error variance. A scree test is performed by plotting the eigenvalues of the factors. Eventually the curve (differences in the eigenvalues) flattens out (the scree). All factors before the inflexion point are to be retained. This procedure is somewhat subjective. With a sample > 200, the scree plot is a fairly reliable criterion for selection (Field 2005).

- Communalities – Communalities are the proportion of variability for a given variable that is explained by the factors. Communalities allow the researcher to examine how different variables reflect the sources of variability. Communalities may also be interpreted as the squared multiple correlation of the variable as predicted from the combination of factors, or as the sum of squared loadings across all factors for that variable. The closer to communities are to 1, the better the factor model explains the observed data. A goal is for all variable communalities ≥ .4. A higher average communality indicates a better model (Field 2005).

- Residuals – The reproduced correlation matrix based on the factor model includes residuals (differences between the model and the observed data). The number of residuals > .05 should be as low as possible; 50% at a minimum. The fewer the number of residuals over .05, the better the model fits the observed data (Field 2005).

- Amount of variance explained (unrotated) – Factors that explain a very small percentage of the variance are unlikely to be of theoretical or practical experience. The goal is to explain as much common variance as possible, at least ≥ 50%.

A "clean" factor structure (best fit to the data) is one where factors have at least three significant variable loadings and there are few or cross loadings (Costello and Osborne 2005).

The default option is to retain all factors with eigenvalues over 1 (Kaiser's criterion). If all the commonalities exceed .7 and there are less than 30 variables or if the sample exceeds 250 and the average communality = .6, then the default option is fine. Alternatively, if the sample is at least 200, the scree test is recommended. However, the different criteria often provide different solutions, so all should be considered in deciding how many factors to retain.

Interpreting the Factors. The factors are interpreted by the variable factor loadings and the communalities of the variables. A factor loading in interpreted as the Pearson correlation coefficient of an original variable (in this case important ratings of various knowledge area or skills) with a factor. Factor loadings indicate an association of the variable with a factor and ranges from 1 (perfect positive association) to -1 (perfect negative association). The relative importance of each variable in indicated by the magnitude of the squared factor loadings.

In social research, .32 is cited as a good rule of thumb for the minimum loading of a variable on a factor (Costello and Osborne 2005) because it equates to approximately 10% overlapping variance. Stephens (1996) provides a table of critical values for a correlation coefficient at α = .01 for a two-tailed test based on sample size based on the formula α (1.96 if p=.1; 2.58 if p=.01; 3.09 if p=.001) x (1/square root of N -1) x 2). Using this method with α =.01, a critical value of .294 is recommended for a sample size of 308 (knowledge) or .296 for a sample size of 304 (skills). To be conservative, a critical value of .32 will be used for this study.

Validating the Factor Structure. The validity of the factor structure and model is established by the Maximum Likelihood goodness-of-fit test and by testing the reliability of each factor using the Cronbach's alpha coefficient. The higher the significance of the goodness-of-fit test, the better the factor model fits the data. For the individual factors a Cronbach's alpha coefficient with a value ≥ .7 indicates a reliable factor.

Factor structure validity may also be established by comparing the correspondence in factor structures that result from different extraction methods. For this study, principal factors analysis and principal components analysis will be conducted and the results compared with the results from the maximum likelihood analysis.

Factor Scores. Factor scores are composite score for each factor based on each variable's contribution to the factor. Individuals' scores for each variable are multiplied by factor score coefficients and the products summed across the variables to yield a factor score (in this case for each degree). These scores can be used to characterize and compare individual degree programs.

APPENDIX I – CLUSTER ANALYSIS PROTOCOL

There are six primary steps in conducting a cluster analysis. The first is to determine if the data is suitable for cluster analysis, second is choosing a similarity measure, third is choosing a clustering algorithm, fourth is determining the number of clusters to retain, fifth is interpreting the clusters, and the sixth is validating the cluster solution (Field 2005, Hair and Black 2006).

Suitability of the Data. Generally, a high subjects to variable ratio is recommended for all multivariate analyses, although in cluster analysis the required sample size is more of a judgment call (Huberty et al. 2006). In this case, we have a large sample, 304, and a high subjects to variables ratio of 13.2 so sample size is not an issue.

As in all multivariate tests, it is important that the sample to be analyzed is representative of the population. For this study, the sample size was large enough for statistical validity and was found to be representative on four parameters so this assumption is adequately met.

Cluster analysis is especially sensitive to the inclusion of irrelevant variables and outliers (Hair and Black 2006). Therefore, it is crucial for the researcher to detect and remove outliers and have a justifiable rationale for including the variables. The survey data was screened for outliers and the inclusion of all the knowledge and skills variables is based on their relevance to environmental programs curricula as determined by a number of experts in the field.

Since cluster analysis use a distance measure to determine cluster membership, differing scales or magnitudes among the variables can influence the results. In situations where the variables exhibit different ranges, the variables should be standardized. In this study, all the variables are measured using the same scale, so standardization is not necessary.

Multicollinearity is a problem in multivariate statistical techniques because it makes it difficult to discern the true effect of multicollinear variables. In cluster analysis, multicollinearity results in a weighting process that affects the analysis. Variables that are multicollinear are implicitly weighted more heavily. If multicollinearity is found in the variables to be used in a cluster analysis, the researcher should delete these variables, compensate for the correlations, or transform or convert the data to remove the multicollinearity (Hair and Black 2006).

Since several of the importance rating variables did exhibit multicollinearity, principal components analysis was used to convert the data into principal components. Reducing the 39 original variables into a set of knowledge components and a set of skills components eliminates multicollinearity while retaining all the variables in the analysis. These principle component factor scores for each degree are used for the cluster analysis. Principal components analysis is conducted according to the same procedures as factor analysis as described above.

Similarity Measure Selection. Interobject similarity is a measure of correspondence or resemblance between objects. In cluster analysis, defining the how this similarity is to be measured for all the pairs of objects is a primary consideration. Three methods are commonly used: correlational measures, distance measures, and association measures (Field 2005, Hair and Black 2006). The correlational and distance measures require continuous data and the association measures are used for categorical data.

Correlational measures represent similarity by the correspondence of the patterns across variables. The measure of similarity represents the correlation coefficients between the profiles of two objects, where higher correlations indicate higher degrees of similarity. Correlations measures are appropriate applications where the emphasis is on patterns among the variables rather than magnitudes.

Distance measures represent similarity by proximity of observations to one another across the variables and are the most commonly used similarity measure for cluster analysis. Smaller distances indicate higher degrees of similarity. The most commonly used distance measure is the squared Euclidean distance which is the recommended measure for the centroid and Ward's clustering methods.

Since Ward's method is our chosen algorithm and our data is continuous with the emphasis on magnitude (principal components scores), the squared Euclidean distance measure was selected for the analysis. SPSS 17.0 software also includes a proprietary clustering analysis method called SPSS Two-Step. The Two-Step method provides numerous tables and figures not included in other analyses which aid in interpreting the results (Norušis 2008). Both Ward's method and SPSS Two-Step method will be used for the analysis and the results compared. The Two-Step method uses a distance measure that gives the best results when the variables are independent, continuous variables with a normal distribution. Principal components factor scores meet these criteria.

Clustering Algorithm Selection. Two types of cluster analysis algorithms are commonly used: hierarchical, in which observations are joined in a cluster and remain so throughout the clustering process, and non-hierarchical, in which cases can switch clusters as the clustering proceeds. Non-hierarchical clustering requires the researcher to pre-specify the number of clusters and therefore is inappropriate for exploratory cluster analysis when no existing theory or justifiable rationale is available to guide selection. Therefore, only hierarchical algorithms were considered for this study since there are no previous studies or theory to justify choosing a particular number of clusters.

Hierarchical procedures construct a treelike structure (called a dendrogram) using one of two methods: agglomerative or divisive clustering. In agglomerative methods, each object (in this case, each set of principal component factor scores for an individual degree program) begins as its own cluster. In subsequent steps, the closest clusters are combined into an aggregate cluster, thus reducing the number of clusters by one in each step. Eventually, all objects are grouped into one large cluster. When the clustering process proceeds in the opposite direction, from one cluster to each object, it is referred to as a divisive method. The five most popular hierarchical agglomerative methods are: single linkage, complete linkage, average linkage, Ward's method, and centroid method (Hair and Black 2006).

Each method uses different rules in how the distance between clusters is computed. Single linkage and complete linkage depend on extreme values and are therefore inappropriate for the survey data which do not exhibit a large range in magnitude. Centroid method often produces messy and confusing results and therefore was also not considered (Hair and Black 2006). Average linkage tends to combine clusters with small within-cluster variation and is biased toward production of clusters with approximately the same variance. Ward's method tends to combine clusters with a small number of observations and is biased toward the production of clusters with approximately the same number of observations. Given these characteristics, Ward's method was chosen as the most appropriate method for this study.

The SPSS two-step method was also selected because it uses a similar hierarchical, agglomerative algorithm and provides additional statistical and figures output which aid in interpretation. The SPSS two-step method is designed to handle large data sets and follows a two-step procedure where pre-clusters are formed as a first step, which are then treated as a single entity (Norušis 2008).

Determining the Cluster Solution. One of the most subjective decisions for a researcher using cluster analysis is determining the final number of clusters (the stopping rule). No standard, objective selection procedure exists. The most commonly used stopping rule is for the researcher to look for large increases in the average within-cluster differences. Using this method, when a large increase occurs, the researcher selects the prior cluster solution. This stopping rule has shown to provide fairly accurate decisions (Milligan and Cooper 1985). A number of other statistical tests or forms of stopping rules have been developed, but most are considered overly complex for the improvement they provide over the simpler method (Hair and Black 2006). The SPSS two-step method provides a stopping rule (Schwarz Bayesian Criterion) to automatically select the best cluster solution.

Ultimately, the final decision on a cluster solution is that of the researcher based upon employing an iterative abductive reasoning process. For this study, several cluster solutions are examined and compared using the Schwarz Bayesian Criterion to measure increases in the average between-cluster differences, theoretical relationships, and practical judgment.

Interpreting the Cluster Profiles. The profile of the clusters is determined by investigating how the clusters vary using the original cluster variables (principal component scores), significant differences across the clusters on variables not included in the analysis (program and degree attributes), and interpretation of the dimensions of difference revealed by the discriminant analysis.

The SPSS two-step method includes output that assists with this interpretation, including displays and tables on the composition of the clusters and the importance of each variable in determining the cluster. For continuous variables the output includes a plot of the mean for each cluster group and simultaneous confidence intervals for the population cluster means. The output also includes plots of *t* statistics that compare the mean of the variables in each cluster to the overall mean.

For both the Ward's method and the SPSS two-step method, the cluster membership variable can be saved and used to examine the relationship between the clusters and any other variables.

Validating the Cluster Solution. Because of the subjective nature of cluster analysis in terms of selecting an optimal cluster solution, it is important to validate the results. No single method exists to ensure validity and practical significance, but several approaches have been proposed.

One of the most recommended methods is to cluster analyze separate samples and compare the correspondence of results (Huberty et al. 1994; Hair and Black 2006). This approach may be impractical because of time and cost constraints so a common variation is to randomly split a sample into two groups and separately analyze each. Given the large sample size, 304, and the representativeness of the sample, this method was selected for verifying the cluster solution for this study.

Another common validation method is to use two different clustering algorithms and compare the similarity of the results. This method was also chosen for this study, using Ward's Method and SPSS two-step method.

A third popular approach is to establish a predictive criterion using variables not included in the analyses but that vary significantly across the clusters. This method is also utilized for this study using two analytic techniques: descriptive discriminant analysis to test fidelity of cluster membership using the original 39 importance rating variables, and KWANOVA to demonstrate significant differences between clusters using variables not included in the cluster analysis.

Cluster Membership. The cluster membership variable may be used to investigate the relationship between cluster membership and other attributes not included in the analysis.

APPENDIX J– INSTITUTIONAL REVIEW BOARD APPROVALS

Oklahoma State University Institutional Review Board

Date:	Saturday, August 23, 2003
IRB Application No:	GU036
Proposal Title:	Study of Environmental Deans' and Directors Perspectives on Program Curricula
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 4/22/2004

Principal Investigator(s):

William J Focht
003 LSE
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Shelia Kennison, Chair
Institutional Review Board

Oklahoma State University Institutional Review Board

Date:	Tuesday, July 10, 2007
IRB Application No	GU0715
Proposal Title:	Study of Higher Education Environmental Programs
Reviewed and Processed as:	Expedited

Status Recommended by Reviewer(s): Approved   Protocol Expires: 7/9/2008

Principal Investigator(s

Shirley Vincent 1216 East 28th Street Tulsa, OK 74114	William J Focht 514B Math Sciences Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
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Sincerely,

Sue C Jacobs

Sue C. Jacobs, Chair
Institutional Review Board

VITA

Shirley Gayle Vincent

Candidate for the Degree of

Doctor of Philosophy

Thesis: A SEARCH FOR IDENTITY: EXPLORING CORE COMPETENCIES FOR INTERDISCIPLINARY ENVIRONMENTAL PROGRAMS

Major Field: Environmental Science

Biographical:

Education:

Completed the requirements for the Doctor of Philosophy in Environmental Science at Oklahoma State University, Stillwater, Oklahoma in May, 2010.

Completed the requirements for the Master of Science in Biological Sciences at the University of Tulsa, Tulsa, Oklahoma in May, 1991.

Completed the requirements for the Bachelor of Science in Cellular Biology at the University of Tulsa, Tulsa, Oklahoma in August, 1986.

Experience:

My skills expertise is in informing collaborative environmental and sustainability decision-making processes through social science research. I have proficiency in a variety of qualitative and quantitative social science research techniques widely applicable to environmental decision-making and policymaking. My knowledge expertise includes U.S. environmental policy and the evolution, identity, and curriculum design of higher education interdisciplinary environmental degree programs. My experience includes consulting on environmental program design, university and college teaching, natural sciences and social sciences research, business management, and higher education administration.

Professional Memberships:

Association for the Advancement of Sustainability in Higher Education (2007-present)
Association for Environmental Studies and Sciences (2008-present)
Interdisciplinary Environmental Association (2006-present)
National Association of Environmental Professionals (2004-present)
National Council for Science and the Environment (2003-present)
Society for Human Ecology (2006-present)

Name: Shirley Gayle Vincent Date of Degree: May, 2010

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: A SEARCH FOR IDENTITY: EXPLORING CORE COMPETENCIES FOR INTERDISCIPLINARY ENVIRONMENTAL PROGRAMS

Pages in Study: 174 Candidate for the Degree of Doctor of Philosophy

Major Field: Environmental Science

Scope and Method of Study:

The study is national in scope, exploratory, and utilized a combination of qualitative and quantitative social science methods.

Findings and Conclusions:

Interdisciplinary environmental (IE) programs in higher education in the United States are both diverse and dynamic in their curriculum designs. Though these characteristics afford flexibility and adaptability, they are also seen as weaknesses that can undermine their perceived legitimacy both within and beyond their host institutions. The lack of a clear identity, definition of core competencies, and prescriptions for interdisciplinary pedagogy can create confusion among program stakeholders and skepticism among institutional administrators. To address these concerns, the National Council for Science and the Environmental sponsored a comprehensive national study to learn more about IE program curricula and investigate the potential for reaching agreement on core competencies. The results demonstrate that a consensus exists on IE field identity: an applied, interdisciplinary focus on the interface of coupled human-natural systems with a normative commitment to sustainability. The results also reveal that IE program interdisciplinary core competency areas consist of three broad knowledge areas and two skill sets, and that three ideal curricular models for IE education are espoused by interdisciplinary environmental program administrators: systems science, policy and governance, and adaptive management. The characteristics and program attributes related to these models are explored and the relationships explained. The study concludes with a discussion of the implications of the findings for building capacity in the environmental professional workforce, a brief description of the next planned phases of the project, and expresses the author's optimism that a consensus can be forged on core competencies and model-specific prescriptions for curricular content for higher education IE programs.

ADVISER'S APPROVAL Dr. William J. Focht