Institute of Ecosystem Studies

Strategic Plan, 2008-2012

Executive Summary

During the next five years, the Institute of Ecosystem Studies, perhaps the nation's premier private independent environmental research organization, will focus its attention on scientific investigations of climate change impacts on ecosystems, the provision of freshwater quantity and quality, human health in the environment, and sustainable sources of biomass energy. It will also enhance its program of public outreach to the media, policy makers and educators on the results and implications of its research. At the same time, the Institute must retrench in some traditional areas of its program, including its formal programs in horticulture, so as to focus resources on its core mission and the better utilization of the Cary Arboretum in support of ecosystem science

Introduction

Science has always been the basis of true human understanding of the environment—from the early observations by Archimedes about the displacement of water by floating objects to the recent report on the decline of North American songbirds from West Nile virus. Without science, we can only substitute superstition and belief to inform our decisions about how to manage the environment.

With the continued rise of human population and the desire of all peoples for a healthy and prosperous lifestyle, never before has there been greater need for science to inform the process of environmental management. Energy shortages and rising CO_2 in Earth's atmosphere suggest that we are simultaneously losing the battle for sustainable resource management and for proper disposal of effluents from an industrialized society. The current human impacts on nature are causing substantial disruptions of the biosphere and threatening the sustainability of the human enterprise. There is no question that humans are the major cause of rapid extinction of the Earth's biodiversity, with unknown and potentially catastrophic effects on the normal function of the Earth's life support system.

Today's environmental issues are complex, taxing the public's abilities and willingness to comprehend the basis and scope of problems, while, at the same time, our citizens are asked to chose amongst difficult, alternative solutions. For instance, how many people understand that ozone can form from volatile organic compounds and atmospheric NO_x, so that traditional air pollution problems are now found far from cities?

How many understand why wetland ecosystems are critical to the cleansing and delivery of fresh water, rather than merely conduits to the sea?

The Institute of Ecosystem Studies (IES) is among the nation's premier independent environmental research organizations and superbly poised to analyze complex environmental problems and to deliver excellent science as a basis for better public understanding and good decisions by policymakers. Formed in 1983 with the vision of Gene Likens, IES is now the home for more than 15 doctoral-level scientists, who are some of the most highly-cited ecologists in the world[1]. Research by IES scientists first documented acid rain in North America, predicted the impact of invasive zebra mussels in the nation's rivers, and unraveled the relationship between woodland mice, blood-sucking ticks and human Lyme disease.

The hallmark of research at IES is application of the ecosystem concept—the belief that all environmental problems must be understood in the context of a holistic view of nature, including the flow of energy and materials through landscapes and a deep appreciation of the role of species diversity[2]. Ecosystems are defined units of study with boundaries that are often chosen for convenience; for instance, the shoreline is a convenient boundary to define a lake ecosystem. The lake ecosystem is connected by streams, rainfall, runoff and seepage to the forest, atmosphere, and groundwater systems that surround it. Indeed, the connections between ecosystems are so strong that some ecologists argue that all life on Earth is held in a single ecosystem—the biosphere, with humans as the dominant species. However ecologists usually find it convenient to study smaller subunits and then conceptualize how the whole is put together. This synthesis is what happens at IES.

The ecosystem approach allows scientists to understand how a perturbation at one level of an ecosystem can affect other processes. For instance, the deposition of acid rain on trees affects more than the upper leaves of the forest canopy. The acidity can leach calcium and other nutrients from the soil[3], lowering the future growth of trees, the amount of calcium for snails to form their shells, and the number of snails that forest birds can find for food[4]. Lower bird populations can allow an explosion of insects, with subsequent effects on tree growth[5]. Only by taking the broadest view of the forest ecosystem could ecologists recognize the full impacts of acid rain. The history of ecology contains numerous examples where the ecosystem approach has allowed a full understanding of human impacts on the environment—nitrogen in rivers, mercury in fish, and rising carbon dioxide on climate change.

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[1] The work of IES scientists is described in detail on its website: www.ecostudies.org

[2] The history of the ecosystem concept is outlined in detail in F.B. Golley's *A History of the Ecosystem Concept in Ecology*, Yale University Press, 1993.

[3] Likens, G.E., C.T. Driscoll and D.C. Buso. 1996. Long-term effects of acid rain: response and recovery of a forested ecosystem. Science 272: 244-246.

[4] Graveland, J., R. van der Wal, J.H. Van Balen, and A.J. van Noordwijk. 1994. Poor reproduction in forest passerines from decline of snail abundance on acidified soils. Nature 368:446-448.

[5] Holmes, R.T., J.C. Schultz, and P. Nothnagle. 1979. Bird predation on forest insects—exclosure experiment. Science 206: 462-463.

IES must respond to the demand for good science to inform the development of environmental policy for these and myriad other human impacts on our natural world. This strategic plan outlines how IES can fulfill its mission during the coming decade. It is the product of a number of meetings and discussions across a broad range of the scientific and administrative staff during the summer and autumn of 2007[6].

As IES enters its next era, choices must be made—among avenues to pursue, among resources to be allocated, and among priorities for focus. Smart choices will lead to the greatest contributions to a better environment for future generations.

Some Views of the Institute of Ecosystem Studies

IES sits in beautiful surroundings—the legacy of the Mary Flagler Cary estate—but in a very real sense, IES is its people. The students, technicians and scientific staff determine what research is done, how it is interpreted, and what impact it will have. With generous base support provided by the Mary Flagler Cary Charitable Trust, IES scientists enjoy unusual freedom to pursue innovative, sometimes risky, research avenues that can lead to real discovery. Indeed, there are few peer institutions that are structured like IES and which are so well endowed[7]. Few university scientists enjoy such academic freedom, unburdened from daily teaching responsibilities. Most corporate and government scientists are mission-driven. Funding rates at traditional agencies, such as the National Science Foundation, are at historic lows (~8%), but IES scientists enjoy some relief from total dependence on uncertain extramural funding. IES scientists are expected to raise 30% of their salary from extramural sources and they are totally dependent on such funding for the conduct of their research—technical help, field and laboratory supplies, travel etc. It is a measure of their innovation and reputation that IES scientists had a 30% success rate in proposals submitted during 2006—more than three times the national average!

The scientists at IES are surrounded by a wonderful support staff, who make the daily chores of grant accounting, compliance, literature searches, and laboratory analysis move forward like clockwork. The scientific staff also has limited involvement with issues of maintenance and facilities management and enjoys its work on the beautiful grounds of the Cary Arboretum. All this contributes to the enormous productivity and

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[6] Although the strategic planning process formally began on 11 June 2007, with a day-long retreat of scientific and administrative staff called by the newly arrived President, William H. Schlesinger, long-term planning has a long tradition at IES, which is recorded in minutes of annual retreats of the scientific staff and with the reports of an *ad hoc* committee for Long-Term Financial Management and Planning, which met during the spring of 2004. Following the retreat in June 2007, President Schlesinger met privately with each scientist to discuss individual perceptions of the goals, capabilities, and limitations of IES. As the summer unfolded, a number of subcommittees of scientific and administrative staff provided input to this report, and comments on early drafts were received from Paul Risser (IES Board Chair), Mike Pace (Assistant Director), Holly Talbot (Comptroller), and Deb Fargione (Administrative Assistant).

[7] These include: The Ecosystems Center at the Marine Biological Laboratory, Wood Hole; the Woods Hole Research Center, Woods Hole; the Archbold Station, Lake Placid, Florida; and the Joseph W. Jones Center, Newton Georgia. A table of comparative data describing these institutions is found in Appendix I.

impact of IES scientists, who have a life-time average of 3.4 publications per year in the primary journals of ecology[8] and who receive an average of 126 citations per year from their peers worldwide.

The Institute provides a number of educational opportunities for students, ranging from a summer ecology camp for elementary and junior high students to curricula for students and teachers nationwide. Each summer IES hosts a program of research experiences for undergraduates, and IES is a frequent home to formal research programs for doctoral and postdoctoral students from neighboring universities. A newly established program in "Ecosystem Literacy" strives to build public understanding of what ecosystem science is, how nature works, and why current human impacts are unsustainable to our future.

Engagement of the scientific staff in the public policy process is gaining momentum. IES scientists provide a biweekly column to the local *Poughkeepsie Journal*, and journalists periodically mention the work of IES scientists in stories about the environment. Some IES scientists have been invited as expert witnesses to legislative hearings and briefings. Work at IES provided the fundamental basis for the Clean Air Act and its amendments, and current work by IES scientists monitors its effectiveness.

While science is the fundamental mission of IES, most of the surrounding community still thinks of it as the Cary Arboretum—the legacy of Mary Flagler Cary's estate. The Institute maintains about 2000 acres of rolling fields and forested hillsides in Dutchess County with a network of roads and trails that are frequented by bird watchers, foliage peepers, and afternoon hikers during the different seasons. Much of the land is purposely unmanaged, to show the natural changes that occur as land is abandoned from agriculture and allowed to undergo succession to forest. Some of the scientists use these lands for field work, and they are used extensively by undergraduates for research projects during the summer. The Institute maintains an atmospheric monitoring station that provides a long-term record of weather, air quality, precipitation chemistry, and solar radiation. In addition to its lands, the Institute maintains a formal horticultural garden, known as Gifford Garden, a native plant display (Fern Glen), and a diverse worldwide plant collection in its greenhouse facilities. Science is central, but the grounds, gardens and greenhouse form the public view of IES.

The Institute operates with a $10 million annual budget, which is 44% provided by endowment income from the Mary Flagler Cary Charitable Trust and from the Institute's own endowments that now total $24 million. The remaining funds are largely derived from research grants garnered by IES scientists and philanthropic donations by friends of the Institute. More than 75% of the budget is spent on research and research-support activities, with the remainder allocated to maintenance of the grounds, greenhouse and gardens. With its core mission focused on science, difficult decisions will be necessary regarding how many ancillary activities should be pursued.

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[8] The current rate of publication, 6.8 papers/scientist/year, at IES is much higher than the long-term career average of its scientists

Responding to the Challenges

The Science Program

Centers of Excellence

Around the world, there is no shortage of environmental problems that need attention, and IES has judiciously chosen to build excellence in some areas and to avoid others. Most of the work at the Institute is in some fashion related to understanding temperate forest and freshwater ecosystems, with major projects focused on the Hubbard Brook forest in New Hampshire and the Hudson River in New York. Within the past several years, IES has played a lead role in developing a program to understand urban ecosystems—the ultimate domination of once-natural landscapes by the human species. IES is the lead institution for the Baltimore Long-Term Ecological Research (LTER) study. Many of the studies at IES have a basis in biogeochemistry—the study of the chemistry of the surface of the Earth and a subject identified as central to the environmental sciences during the next several decades[9].

These focal groups have emerged organically from the scientists themselves, the collaborations they found productive, and the intellectual avenues they found fruitful. There is much collaboration among IES scientists: during 2006, 22 % of the publications from IES had more than one IES author; 8% had 3 or more. The Institute has also maintained a healthy balance between basic and applied work. For the future, however, it seems likely that some identified focal areas of excellence would be beneficial, so that IES can be the best, and best known, in well-defined areas of work. The most promising of these are **climate change impacts on ecosystems, the provision of freshwater quantity and quality, human health in the environment,** and **sustainable sources of biomass energy**. These areas would focus hiring priorities; they are not seen as resulting in new internal structure (e.g., departments) or administrative hierarchy (e.g., area chairs) that would construct barriers within the existing scientific staff.

Institute scientists are not so presumptuous as to think that they are the first and only people to think that the general topics of climate, water, health, and energy are among the most important environmental topics for the future. However, with the specific modifiers that are applied to the definitions of the focal areas, IES can build teams that will have the greatest impact on the environmental problems that face us now and in the near future.

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[9] *Global Change Ecosystems Research*, National Academy Press, Washington, 2000; *Grand Challenges in Environmental Sciences*, National Academy Press, Washington, 2001; *Global Environmental Change: Research Pathways for the Next Decade*, National Academy Press, 1998.

Diversity

The Institute's core scientific staff was assembled over a short period in the mid-1980s, leading to a narrow age range among its members and an unfortunate lack of gender and ethnic diversity. It is essential to add new, young scientists to the ranks of the Institute and to make every effort to engage a broad range of diversity in the new hires. The public and policy makers will pay the greatest attention to its findings if they see that the work at IES comes from women and men across the full range of age, social, and ethnic groups that make up the fabric of this country.

Numerous reports of the National Academy of Sciences and other agencies stress the importance of women and diversity in science.[10] Science is carried out by communities of investigators, having different perspectives, motivations, approaches, and skills. Diversity of gender, ethnicity, culture, and age are among the characteristics that contribute to the success of science. Diversity of background, perspective and motivations is a mainstay of objectivity in science[1].

As with scientific institutions worldwide, gender diversity in the core IES scientific staff is considerably lower than the pool of PhDs that graduated from ecological and biological science programs from the early 1980s. Although twelve percent (12%) of the core scientific staff is female, the pool of PhDs from 1983 to the present has grown from 30% to 50%[11]. Racial diversity is also low within the scientific staff.

Diversity at IES is also limited by the uniform academic age structure of the core scientific staff. A significant proportion of the core scientific staff appointments were made at the entry level within a 10-year window. As a result, there are currently no scientists at the Assistant or Associate rank.

There is an immediate need to create both gender and career-stage diversity within the core scientific staff at IES. Beyond hiring the best and brightest professionals to join the staff, a guiding principle for hiring in the core scientific staff is to increase diversity to at least 40% women during the next 6-10 years. Adequate gender diversity must be established at all academic levels, while adding significantly to the diversity of professional ages. A significant body of research suggests that new strategies must be adopted in order to recruit, hire, and retain women and people of color. IES will institute cultural changes that have been identified as encouraging and retaining diversity, including (1) raising cultural awareness through a cultural audit; (2) appointing women and minorities to leadership roles and to important committees; (3) instituting mentoring programs; and (4) regular monitoring of progress toward a greater diversity of the scientific staff.

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[10] *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering.* 2006 National Academy of Sciences, Washington, D.C.

[11] *ibid*

Proposed Hiring

Recognizing the immediate need for greater diversity, and the need to build strength in identified core areas of research, we propose five hires during the next few years, as budget permits, in the following areas:

1. **Environmental health**—recognizing that the epidemiology of infectious diseases that are associated with animal vectors (usually insects), such as West Nile Virus and Lyme disease, can only be understood in the context of the natural ecosystems that are increasingly inhabited by humans.

2. **Climate change impacts on forests**—recognizing that changes in the future growth and distribution of forests will alter the supply of forest products to humans and the ability of forests to supply other services to humans (e.g., cleansing of air and water, storage of carbon, habitat for biodiversity).

3. **Impacts of energy production and use**—recognizing that photosynthesis in natural ecosystems is very likely to replace at least some of our society's dependence on sources of fossil energy and that we have only a rudimentary understanding of the impacts of widespread management of the landscape for biomass energy and the impacts thereof on ecosystem function.

4. **Freshwater ecosystems—**building on the area of greatest traditional strength at IES, whose scientists have elucidated the natural processes that cleanse and deliver water for human use, the human impacts on wetlands, and the changes to be expected with global warming.

5. **Microbial biogeochemistry**—recognizing that microbes are central to the ability of natural ecosystems to process the exogenous delivery of substances and to determine the outflow of materials to downstream or downwind systems.

It is important with each of these proposed hires that the selected individual bring a new set of skills and approaches that will be synergistic to the current staff at IES and allow the development of successful, interdisciplinary grant funding and research in new areas of work. It is also critical for recruitment that IES provide full salary support until the new scientists can firmly establish their research program at the Institute. IES should be in a position to provide major specialized equipment to aid the professional development of new scientists who join the Institute.

Implications for Total Staffing and Anticipated Retirements

These new hires will produce an initial "bulge" in the size of the scientific staff at IES. At the same time several individuals have discussed potential retirement during the same interval, so that by 2012, it is likely that the scientific team at IES will return to its current

core of 16. To reduce anxieties among the scientific staff, President Schlesinger has appointed and charged an *ad hoc* committee to formulate a policy for retirement from IES and to recommend privileges for its emeritus scientists.

Cary Conferences

To help promote the synthesis of science, Gene Likens initiated the program of Cary Conferences in 1985, and IES has convened eleven such conferences in the past 22 years. These conferences bring together an international group of scientists who are at the forefront of ecology or allied disciplines to assess the progress and future work needed on major issues in the field. The conferences have promoted new directions such as the more explicit incorporation of humans and human-driven processes in ecological research. These conferences have also evaluated critical areas: such the ecological basis for conservation and approaches such as ecological modeling. The Institute will continue to organize Cary Conferences, perhaps changing the frequency to every three years. These gatherings will examine important scientific issues that confront ecology and society.

Programs for Visiting Students, Scientists and Educators

All IES scientists agree that frequent visits by scientists and educators from other institutions, annual programs for undergraduates, and longer studies by doctoral and postdoctoral students are essential to refresh ideas and invigorate the intellectual environment at the Institute. Funds to support these visitors are derived from a variety of sources, especially the National Science Foundation's generous support for the Research Experience for Undergraduates (REU) programs at IES during the past 20 years. A fund-raising priority for IES is the procurement of some endowment funds to support other visitors, including a weekly program of public lectures at the Institute.

The Ecosystem Literacy Initiative

The Ecosystem Literacy Initiative (ELI) aims to help people understand their connections to the natural world. The mission is to develop a "language" of ecosystems for the public, leading to a citizenry capable of engaging in informed and coherent dialog about ecosystems. ELI is a coordinated set of programs that define and promote ecosystem literacy, addressing four broad and overlapping audiences: policy makers, educators, scientists and the general public. The activities link current research and scholarship about teaching and learning with development of innovative programs and resources for educators.

ELI is defining what ecosystem literacy is, where it fits into the broader frameworks of ecology, scientific literacy, and environmental stewardship, and how it can be described and measured. A learning progression for ecosystem literacy, identifying key sequences for teaching and learning, will be a unique and invaluable

product of this work. ELI must identify how teachers can best teach about ecosystems, how communication and collaboration can facilitate information exchange, and how the current practices and needs of formal and non-formal educational systems can foster ecosystem literacy.

ELI will create new instructional materials for teaching about ecosystems across the K-12 curriculum. These materials will populate a website that will include the ecosystem literacy framework and learning progression, insights from research about teaching and learning, curriculum materials and other resources for teachers. In addition, ELI will continue to provide professional development and practical support for educators through innovative programs focusing on cities (e.g., Baltimore) and the Hudson Valley, while expanding to include teachers nationwide.

In order to achieve our vision for ELI during the next five years, the following things are needed:

1. Continued and strengthened collaborations with the full scientific staff in the mission and substance of ELI.
2. New staff and associates at the PhD level with capabilities in education research and curriculum development.
3. Enhanced web, graphics, design and writing capabilities through new staff, new contractual arrangements and professional development and support of existing staff.
4. New and enhanced connections between IES and the education research and policy arenas.

We envision that incremental funding for these needs can be obtained from grants written to public and private agencies.

Public Communication

IES is committed to the concept that science is not complete when it is merely published in the peer-reviewed journals that form the primary scientific literature. Despite the availability of the Internet, much of this science is inaccessible to the public because of its complexity, jargon, and lack of context. Some is insidiously misinterpreted by others to foster political ideology. Since much of the work is funded with taxpayer dollars, scientists have a responsibility to translate and transmit their findings to the public, the media and policy makers. This does not necessarily mean that the scientific process is politicized; there is nothing political about a scientist describing what was measured, what was found, and what it might mean for the environment. Indeed, if scientists do not do it, it is likely that someone else will—with unknown consequences.

The Institute will begin an enhanced program of public communication of its findings—ranging from an explicit emphasis on the importance of such outreach as an expectation of the scientific staff, to enhanced website and newsletter design, and the

preparation of a media guide featuring the expertise of IES staff. IES must add an additional full-time employee to coordinate media and press relations for the Institute. IES needs to develop and maintain personal contacts with influential journalists and Capitol Hill, where scientists from IES should be routinely available for expert testimony on current issues.

Scientific staff participation will be essential in any public relations program for IES. Motivating the scientific staff will likely require changes in their reward system as well as the allocation of resources to defray the costs of their participation. To maximize outreach potential, IES will identify the information niche(s) that IES is best poised to fill; methods for maximizing the effectiveness of information exchange; and a reward system that will encourage staff participation while balancing other core missions. The latter includes fostering a culture of information exchange and recognizing excellence in outreach during performance evaluations. We will also seek outside expertise to help us learn effective pathways of communicating science to target groups, along with partnerships that maximize engagement.

"Branding"

The scientific community knows the Institute by its formal name or simply as IES, whereas the local community often refers to IES by its former name—the Cary Arboretum. Indeed, many local citizens have a limited idea and understanding of what happens at IES, thinking only of it as the location of some gardens and an annual plant sale. Outside the scientific community, the Institute has virtually no name recognition, and the concept of an ecosystem has limited resonance amongst the educated public.

We believe that renaming the IES as the Cary Institute of Ecosystem Studies, or simply the Cary Institute, would offer a number of advantages in branding, name recognition and advertising of its activities. For instance, the Jackson Lab (Bar Harbor, Maine), the Salk Institute (San Diego), and the Max Planck Institute (Germany), all have names honorific of individuals and excellent brand recognition in their respective fields. Adding the name of Cary to the Institute memorializes the essential and lasting support derived from the estate of Mary Flagler Cary and the generosity that has allowed the Institute to be what it is today.

The Institute has recently engaged the consulting firm, Clear Agenda, to help hone its brand and market image and to enhances its ability to raise philanthropic donations to support programs.

Facilities

The scientific program of the Institute is housed in three modern buildings, which include an auditorium, small meeting rooms and classrooms, staff and administrative offices, and laboratory facilities, for a total of 53,100 square feet of net (usable) space. These core facilities are supplemented by separate buildings that house most of the

educational programs and the greenhouse facility. A number of small houses that function as dormitories for visiting students and scientists complete the infrastructure of the Institute, which has few issues of deferred maintenance and adequate space for the scientific and educational programs for the next several decades. To enhance communication among workers, it may be advisable to consolidate the education program and the space for postdoctoral visitors in the central Plant Science Building and to move all administrative offices to Gifford House. Gifford House provides a more visible entrance point for the public who may be curious about what IES does and an easy entrance for donors, media, and policy makers, who we want to visit us.

1. Laboratories

Within the Gene E. Likens Laboratory, the Rachel Carson Analytical facility is equipped to provide chemical analysis of most standard ecological materials—air, water, soil, and plant samples—with well-established procedures of quality assurance, quality control, and cross-calibration of new instruments as they are acquired. The analyses are performed by IES staff for standard fees that are included in applications to funding agencies. Specialized sample preparation and development of new analytical methods are performed in the laboratories of the individual scientists. Preparation of soil samples and acid washing are isolated from the analytical facilities in order to minimize the possibility of sample contamination.

In its annual budget, the Institute includes a contribution to a discretionary fund which is designed to replace, upgrade, and expand the laboratory equipment on a regular basis. In recent years, financial constraints have not allowed this contribution, which should be reinstituted as soon as possible. It is likely that one or more of the anticipated new scientists will require instrumentation, data processing and information services that are new to IES, perhaps costing as much as $500,000 each.

2. Housing and Dormitories

The Institute can house more than 50 visitors in dormitories, apartments, and houses on its grounds. During peak periods, for example Cary Conferences and the summer field season, these facilities are fully utilized, but at other times only a fraction of the space is full. Some alternative, commercial housing is available near the Institute, so it is likely that the amount of housing at IES can be reduced and utilized more efficiently with considerable cost savings in maintenance and custodial care. It is also possible that some of the houses could be leased to employees and others on a long-term basis to provide better cost recovery for the overall housing operation.

3. Boats and Vehicles

The Institute maintains a vehicle fleet to support its scientific, maintenance, and grounds-keeping, and a vehicle maintenance shop. These vehicles range from small cars and pickup trucks to medium-duty trucks. Several snowmobiles allow wintertime access to research sites in New Hampshire. A portion of the fleet was purchased with funds from

grants, but more than 30 vehicles originate from Institute funds. It is likely that the overall size of the vehicle fleet can be reduced, and some efficiencies and savings could be rendered by a thorough re-evaluation of vehicle usage.

The Institute also maintains four small boats for sampling lake and river ecosystems and a trailer for hauling the largest of these (a 19-foot Boston Whaler). This fleet is adequate for the current research program at IES and has limited financial impact on the Institute's annual budget.

4. Library and Information Services

In the world of science, it is just as important to look backward to what has been done before as it is to look forward to the exciting unanswered questions and new techniques, equipment and facilities that can be brought to bear on them. The library at IES maintains holdings of 175 important journals and nearly 10,000 books in ecology and related fields. Access to the larger literature of science is maintained by subscriptions to electronic journals and various web-based databases, such as JSTOR, BioOne, and the Web of Science®. Although the library is not identified as an area of growth, these holdings will be maintained and electronic access expanded to serve the scientists and students who need it.

5. Information Technology

Every scientist and staff member at IES has access to a computer, email, the Internet, Microsoft Office application software, letter and poster printers. Centrally installed software on all computers includes the operating system, Office, anti-virus, and backup software. Where users have individual needs or preferences, they purchase additional software such as citation, statistical, modeling, and GIS applications with limited support from IT. An open-access computer cluster is located in the library for use by visiting scientists and students. A shared GIS workstation is also available. Department servers process accounting, payroll, human resources, development, library, and lab databases. Many of the policies, procedures, and forms for the daily operation of IES are accessed through its intranet site. All computers are connected to an IES network that backs up user documents to an off-site server. Together with central security systems that minimize "spam" email, viruses, and prevent entry by computer hackers, this system ensures the safety of large and long-term datasets. Computers and their peripherals are replaced as they fail or as user needs increase. A key IT function is to continually assess the needs of users and research the technologies that meet those needs. We strive to provide proven, cost effective technologies, where they will increase capabilities and efficiency. Although it is impossible to predict the computational needs of scientists who might join the Institute, the current allocation of resources to information technology services seems adequate for the near future.

6. Greenhouses and Gardens

The greenhouse was used modestly for research in the past, but it houses no current scientific activity. Unfortunately, public visitations are also few, so it seems advisable to close the greenhouse operations at the end of FY08 (30 June 2008) for budget savings of nearly $180,000/year. Similarly public use of the formal gardens does not justify the annual expense of maintenance, nor is it likely that the gardens at IES will ever compare favorably with the large, formal gardens maintained locally at Innisfree and Wethersfield. A reduction in the overall horticultural program will allow a reduced staff to focus its attention on the grounds of the Institute, and we anticipate approximately $100,000/year savings from this reallocation of effort from gardening to the provision of a network of self-guided trails, with guidebooks and signage, that highlight the ecosystems on the Institute's grounds, natural processes such as plant succession, and some of the ongoing research programs. We will also expand the hours for visitors, and if funds permit, we will add a resident naturalist to the staff to conduct public walks and programs on the grounds. Gifford House and its parking facilities should be reconfigured to form a more welcoming public entrance to the IES grounds and trails.

Given the history of the Cary Arboretum, these recommendations may seem radical, but they are not new. Both were noted by the Committee on Long-Term Financial Management and Planning in the spring of 2004, as important cost-saving measures[12]. Closure of the Gifford Garden and the Greenhouse can probably be accompanied by a public sale of its plants, although it will perhaps be desirable to allow the New York Botanical Garden and other local organizations to select specimens that enhance their collections. To minimize ongoing maintenance, the Greenhouse facility should be rented to a commercial user or dismantled.

7. "Greening"

In recent years there has been considerable enthusiasm to reduce the impact of IES on its environment—both locally and globally by the purchase of a hybrid vehicle for its fleet, installation of waterless toilets for its restrooms, and reglazing of the greenhouse windows with double-pane acrylic to reduce winter-time heat loss. IES has also engaged an engineering firm to design a heat-exchange system for the Likens Laboratory, to reduce heat loss from the laboratory fume hoods. Although these projects are laudable and some pay for themselves over a moderate number of years, it is not likely that IES can embark on a large-scale greening of its facilities, given the budget realities of the next five years. IES must focus on ways to green its facilities with minimal investment of new funds. For instance, a high level of "greening" of the IES facilities will be achieved by eliminating 20,000 gallons/year of fuel oil consumption, used to heat the greenhouse facilities, providing a savings of approximately $45,000/year.

[12] In 1976 an outside review recognized that the available funding could support a major emphasis on horticulture or environmental science, but not both, at the Cary Arboreum. In 1979 another review found the greenhouse to be "overbuilt" in the context of the rising costs of energy, nearly 30 years ago.

Budget:

In March 2009, the Mary Flagler Cary Charitable Trust (MFCCT) will provide IES with a final grant of $69.7 million to manage in perpetuity as its own endowment and to provide an anticipated annual revenue to IES of approximately $3.5 million. Using the current protocol—a spending rate of 5% of the 3-year rolling average value of endowment—these earnings will grow modestly during the next five years. However, it is hoped that the long-term growth of this endowment will match the recent performance of IES's own endowment funds, so that the spendable income will increase in the future. The Finance Subcommittee of the Board of Trustees of IES will oversee the investment of these various endowment funds.

While IES scientists have been successful in garnering a sizeable amount of research funding from extramural sources, the rate of spending of those grants, which determines the indirect cost recovery (ICR), has been showing a slow decline during the past few years (Figure 1). Some of this slowing can be attributed to increasing competition for limited Federal grant funds. Thus, a major challenge facing IES is to increase grants received and ICR during the next five years. Additionally, IES generates more than $4,000,000 in extramural research funds each year, but the ICR is only 21% ($850,000), rather than the full institutional rate of 47%. Emphasis must be placed on grants and granting sources that allow a full recovery of overhead on research expenditures.

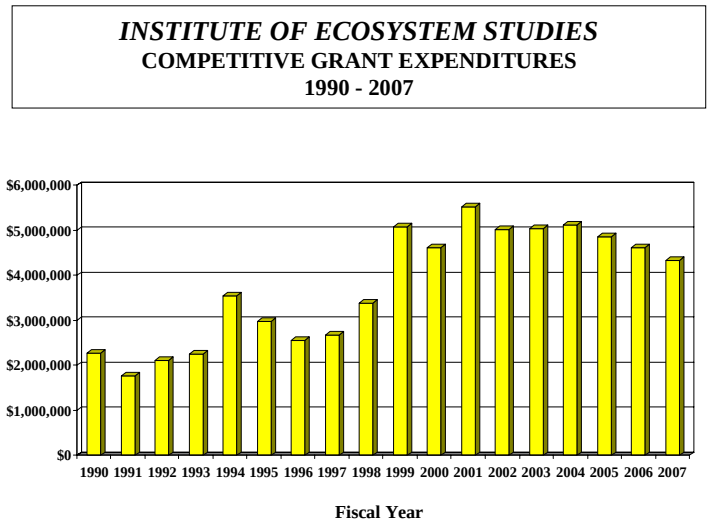


Table 1 shows the budget anticipated with the implementation of this strategic plan during the next five years, assuming the addition of two scientists in FY09, other staff additions as mentioned in this report, the retirement of four scientists between 2009 and 2012, a modest reduction in other staff positions and in the vehicle fleet, and closure of the greenhouse and the garden facilities at the end of FY08. The budget includes a

program to incentivize IES scientists to recover more of their annual salary from grants[13]. We also anticipate some modest increases in revenue and reductions in cost from a more efficient management of the IES on-site housing. The budget includes an annual contribution to reserves for equipment purchases and deferred maintenance.

The budget unbalanced even with the anticipation that approximately $500,000 can be raised each year through development activities. While this is an ambitious goal in light of recent development returns, it is potentially achievable with a greater effort towards branding and public communications, as outlined herein.

Table 1. Budget projections for 2008-2012

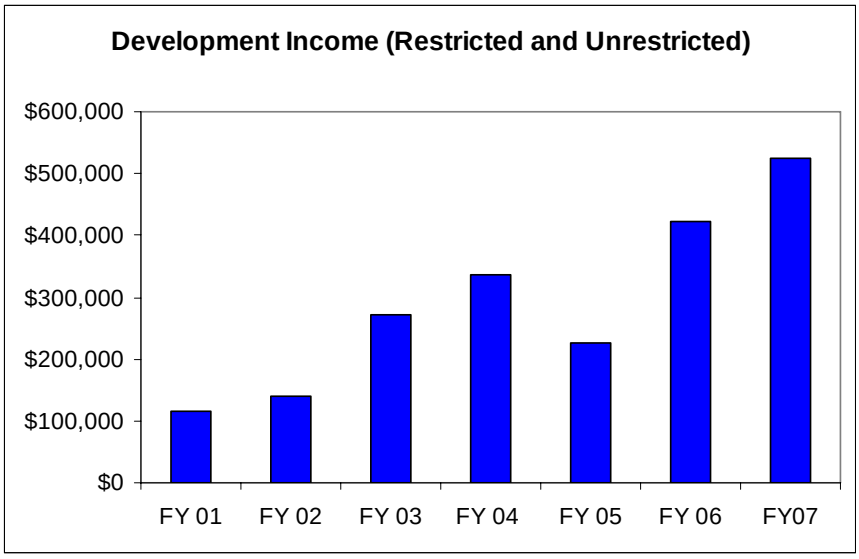
	FY 08 Budget	FY 09 Projections	FY 10 Projections	FY 11 Projections	FY 12 Projections
Revenues					
Cary Base Grant	$ 3,486,159	$ 3,486,159	$ 3,486,159	$ 3,538,451	$ 3,662,297
IES Endowment Contribution (net of fees)	980,690	1,085,906	1,151,060	1,220,124	1,293,331
Direct Costs from Grants	3,579,184	3,412,900	3,541,974	3,347,874	3,187,500
Indirect Costs	850,000	810,500	841,159	795,053	756,955
Education Revenue and Fees	27,500	27,500	28,000	28,500	29,000
Interest	24,000	22,000	20,000	20,000	20,000
Development	830,000	500,000	550,000	600,000	650,000
Auxiliary Enterprises	132,000	80,000	80,000	80,000	80,000
From Reserve Fund	158,385				
Miscellaneous	5,000	5,000	5,000	5,000	5,000
Total Revenues	$ 10,072,918	$ 9,429,964	$ 9,703,352	$ 9,635,002	$ 9,684,083
Expenses					
Scientific Research and Training	$ 1,960,887	$ 1,940,287	$ 1,967,146	$ 1,930,028	$ 1,869,544
Direct Costs from Grants	3,579,184	3,412,900	3,541,974	3,347,874	3,187,500
Finance and Administration	2,109,977	2,107,837	2,192,150	2,279,836	2,371,030
Physical Plant	1,050,445	873,484	899,689	926,680	954,480
Greenhouse, Grounds & Gardens	633,981	375,750	387,023	398,633	410,592
Public Education	185,711	164,601	169,539	174,625	179,864
Library	184,601	195,091	204,845	215,088	225,842
Development	207,766	284,994	293,544	302,350	311,421
Board and Committee Expenses	28,702	28,867	29,733	30,625	31,544
Auxiliary Enterprises	22,975	24,475	25,699	26,984	28,333
NYSERDA Projects - Loan Payments	40,388	28,764	28,764	28,764	28,764
Capital Improvements/ Reserves	18,300	18,300	100,000	150,000	200,000
Merit Pool	50,000	70,000	72,800	75,712	78,740
Total Expenses	$ 10,072,918	$ 9,525,349	$ 9,912,905	$ 9,887,197	$ 9,877,653
Surplus/(Deficit)	(0)	$ (95,386)	$ (209,553)	$ (252,195)	$ (193,570)

[13] The budget in table 1 includes an incentive program that returns half of the ICR from salary recovery above 30%/yr to the individual investigator for discretionary use.

The projected budget shortfall has several origins, but it largely stems from an attempt to pursue too many different avenues at IES. A goal of delivering excellent science, while at the same time maintaining extensive horticultural activities and a large physical plant is a laudable, but unrealistic. Among peer institutions, both the Ecosystems Center and the Woods Hole Research Center focus on science, without managing a large physical plant or acreage. Despite the generous endowment from the Cary Trust, it is unrealistic to think that IES can support staffing that is currently higher than at most of our peer institutions (Appendix I). IES has achieved scientific excellence in productivity and impact, but in a time of uncertainty in future Federal R&D expenditures and the nation's economic growth, IES must radically reduce the costs of its overall program through the changes advocated in this plan.

Development

With independence from the New York Botanical Garden and establishment of a Board of Trustees in 1993, IES initiated a development program. The initial phase of this effort culminated in a capital campaign that raised over $6 million, leading to the G. Evelyn Hutchinson endowed chair and the building of the Likens Laboratory. Subsequent to the campaign the development effort focused on annual giving and selected grant and other private funding opportunities. This work has resulted in a gradual increase in annual philanthropic revenues during the post-campaign era as reflected in the graph below for fiscal years (FY) 2001 through 2007.



Despite the increase in these funds in recent years, IES has limited fund-raising capacity. The Institute's scientific focus appeals to a modest constituency that understands what IES does. In addition, some supporters are drawn to the Institute through gardening and horticultural interests, but this area does not represent the current or future focus of IES. The Institute must seek donors who are motivated to give based on the importance of environmental science.

Looking forward, IES must create a development program that integrates well with the new public outreach and "branding" efforts to enhance the Institute's visibility and widen appeal to donors. IES will need to acquire major gifts from individuals as well as seek private foundation support for particular initiatives. These efforts will take time. Over the next five years IES needs to create a base of annual support that exceeds a half million dollars. IES will also need to increase this base each year while cultivating the supporters that could give large gifts. These efforts will be vital to the future of the organization and require ongoing effort from the President, Board of Trustees, and senior scientific leadership.

To carry forth these goals the Development program at IES will need a major new emphasis in branding, marketing, and solicitations, focused on high-end philanthropic individuals and foundations that support environmental programs. Within the constraints of budget, several new staff will be necessary to track and research gift prospects and to write proposals for major philanthropic efforts.

Appendix I

Institution	Number Scientists	Total Staff	Annual Budget (millions)	% from extramural grants	Endowment (millions)	Staff per scientist	Endowment per staff	Since Inception[1] Publications per year	Citations per paper	Institutional H-value
Institute of Ecosystem Studies Millbrook, NY	16	110	$10.0	44%	$ 94[2]	5.8	$ 855,000	45	33	86
The Ecosystems Center Woods Hole, MA	12	50	7.9	80	5.7	3.2	114,000	35	34	93
Woods Hole Research Center Woods Hole, MA	13	35	8.4	79	3.7	1.7	106,000	14	29	49
Archbold Station Lake Placid, FL	5	55	4.7[3]	56	41	10.0	745,000	8.5	12.5	29
Joseph W. Jones Center Newton, GA	9	44	8.0	2.5	156[4]	3.9	3,545,000	8.6	11	23

[1] All publication data are from the Web of Science and thus do not include books or book chapters. Publications per year is the total listed divided by the years of operation (e.g., IES beginning in 1984)
[2] Endowment includes $24 million at IES, plus $70 million managed for IES by the Mary Flagler Cary Charitable Foundation
[3] Includes $1million/year for agricultural operations at the MacArthur Agro-ecology Research Center
[4] Endowment managed by the Robert Woodruff Foundation to yield $7.8 million in annual income for the Jones Center