1) **Major accomplishments over the last five years.**

The Ecosystem Informatics program at Oregon State University has established a presence here at the University and on a global scale. The OSU Ecosystem Informatics IGERT Program (with NSF funding 2004-2011 and strategic initiative funding 2005-2009) has been extremely successful. Four junior faculty were hired and have made major contributions to teaching, research, and graduate advising in this radical interdisciplinary area. Thirty PhD students have been funded on fellowships, and an additional 5? have taken the EI minor. Students are enthusiastic, extremely articulate and conducting successful collaborative cutting edge research that addresses major issues and is accessible to a broad interdisciplinary audience. Student posters and oral presentations are first rate, publications are professional and published in diverse highly ranked peer reviewed journals. The publication list is impressive in productivity and breadth of fields represented. Several of our students have been engaged in international internships. All graduates have found employment quickly after graduation. We have had a successful program with no attrition of students and integrated the junior faculty, made possible by the Provost funds, into leading the EI IGERT program.

For the fifth year, Ecosystem Informatics IGERT students from all five cohorts, IGERT PIs, and many faculty advisors joined together in the annual boot camp experience, a five-day field course at the magnificent old-growth forest and stream ecosystems of the HJ Andrews Experimental Forest and NSF-funded LTER site. The boot camp involves visiting study sites where long-term ecosystem experiments are underway, and discussing the ecological, mathematical, and computer science aspects of the work underway. This year we visited long-term watershed experiments, a 200-year log decomposition experiment, and a fire tower, and discussed mathematical and computer science problems involving ecosystem fluxes.

IGERT students collaborated in team projects integrating machine learning, applied probability, and mathematical models to the study of selected ecological problems. Students are grouped into teams of one or two ecologists, a computer scientist, and a mathematics student, and they are supervised by a team of faculty (ecologist, computer scientist, and mathematician). Their work is presented as a written report and an oral presentation with feedback from other teams.

Ecosystem Informatics IGERT trainees learn to use machine learning methods suitable for ecological problems. This year they focused on Bayesian networks and Hidden Markov Models, including problem definition, model formulation, and solutions using Genie and Matlab.

**Specific Examples:**

Ecosystem Informatics IGERT trainee Alan Tepley (Forest Science and Geosciences) has been collaborating with IGERT co-PI Enrique Thomann (Mathematics), IGERT PI Julia Jones (Geosciences), and faculty advisors in the US Forest Service (F.J. Swanson and T.A. Spies) to understand how variable severity fire influences forest stand structure and development. Many forests do not have a simple fire regime with only high or only low severity fire; instead, in variable severity fire systems fire may be low severity in some locations or times and high severity at other locations or times. Existing analytical mathematical models do not work well for variable severity, so researchers have had to use simulation modeling. Alan’s work has shown that it is possible to extend existing analytical mathematical
models to the case of variable severity fire, producing rich insights about the process and the resulting forest conditions.

Ecosystem Informatics IGERT trainee Nicole Czarnomski (Water Resources Engineering) has been collaborating with co-PI Ed Waymire, her faculty advisor Desiree Tullos (biological and Ecological Engineering) to develop a mathematical model of the fluid dynamics and sediment transport in stream channels where vegetation occurs. An IGERT internship at the USDA-ARS National Sedimentation Laboratory in Oxford, Mississippi (internship mentor Andrew Simon) enabled Nicole to conduct a flume experiment testing the mathematical model. Nicole’s modeling and experimental work shows that stream restoration involving the planting of vegetation along streambanks can accelerate bank erosion under certain circumstances, producing an undesirable outcome from restoration activities, which are intended to stabilize streambanks and prevent erosion.

Ecosystem Informatics IGERT trainee Phoebe Zarnetzke (Zoology) has been collaborating with Peter Ruggiero (Geosciences), and her advisors, Eric Seabloom and Sally Hacker (Zoology) to understand the factors that contribute to expansion of invasive grasses on sand dunes along the coast of Oregon and Washington, the effects of this invasion on dune shape, and possible feedbacks. Based on exploratory modeling conducted as part of a team project with fellow IGERT students in geography (Tracy Kugler) and mathematics (Ben Morin), Phoebe conducted an experiment testing the effects of different grass species combinations and densities on sand retention, using a wind tunnel as the Oregon State University Tsunami Research Lab. Her experiment showed that species composition and density affected sand accumulation, providing initial support for the notion that dune invasion by non-native species may alter dune shape and produce positive feedbacks for continued dune invasion.

Trainee Elizabeth Burrows defended her PhD in Biological and Ecological Engineering, a set of studies of the potential for hydrogen production for renewable energy from cyanobacteria. One piece of this work involved laboratory development of a high-throughput assay that improved the production of hydrogen from cyanobacteria compared to other methods. However, this improvement was greatly increased by collaborating with computer scientists. Liz and her collaborators developed an optimization procedure that increased the production of hydrogen nearly 400-fold compared to existing methods. Schrader, P., Burrows, E., and Ely, R. 2008. High-throughput screening assay for biological hydrogen production. Analytical Chemistry. Anal. Chem. 2008, 80, 4014-4019; Burrows, E.H., Wong, W.K., Fern, X. Chaplen, F.W., Ely, R.L. Optimization of ph and nitrogen for enhanced hydrogen production by synechocystis sp. Pcc 6803 via statistical and machine learning methods. To appear in Biotechnology Progress.

Trainee Stephen Mitchell defended his PhD in Forest Science, a set of studies of the effects of forest fire on carbon storage. He showed that forest thinning practices, currently being implemented in many western forests to reduce fire occurrence, do alter fire severity, but they also may result in a net decrease in carbon storage. This finding is unexpected and important for public land managers. Stephen showed that commonly used models for predicting the exchange of carbon dioxide between forests and the atmosphere are subject to large sources of uncertainty. Mitchell S.M., Harmon M.E., & O’connell K.E.B. 2009. Forest fuel reduction alters fire severity and long-term carbon storage in three Pacific Northwest ecosystems. Ecological Applications. 19:3, 643-655; Mitchell, Stephen R; Keith J Beven; Jim E Freer. 2008. Multiple sources of predictive uncertainty in modeled estimates of net ecosystem CO2 exchange. Ecological Modelling in press.

Ecosystem Informatics IGERT trainee Chris Graham defended his PhD in Forest Engineering, a set of studies of water flowpaths in forested watersheds. In an internship, Chris conducted replicated experiments in Oregon, Georgia, and New Zealand involving irrigation of forested hillslopes and tracer tests. This work demonstrated that water added to the soil surface of these forested hillslopes infiltrates to depth and then travels rapidly downslope, with major implications for understanding flood generation and
2) In previous annual reports, you have included your thoughts about where you wanted to be when your initiative was fully developed/matured. Please comment on this, and how you see the future of your initiative.

We have accomplished many of the goals that we initially established. See specific comments below. We have a very strong and exciting collaboration involving senior faculty, junior faculty, postdocs, and PhD students across the campus. We have allocated all the fellowship funds from the IGERT award. However, the demands of ecosystem informatics are sufficiently high, and the field sufficiently new, that students still require fellowship support to engage in this area of work. As a result, the courses in the Ecosystem Informatics minor do not have high enrollments. We submitted a renewal IGERT proposal to NSF in October 2008, which came very close to being funded, but was ultimately declined. With the encouragement of our External Advisory Board and other PIs who have received NSF IGERT renewals, we are planning on attempting another renewal again in 2010. In the interim, 18 students are continuing work on PhD research, and the eleven core faculty will continue to meet regularly, pursue research collaborations, and share colloquia.

Broad Goals

- **Establish OSU as a top university in the world for interdisciplinary mathematical and computer based modeling in select areas of ecology.**
  We have a very strong and exciting collaboration involving senior faculty, junior faculty, postdocs, and PhD students across the campus. Our group is beginning to be recognized nationally and internationally through its research record and the quality of PhD graduates.

- **Demonstrate the relevance of Ecosystem Informatics for natural resources management in Oregon and the United States.**
  Many research projects underway in the Ecosystem Informatics program address key natural resource management issues, such as fire, biological diversity, river restoration, invasive species, and other topics. Publications of PhD graduates are beginning to emerge and these demonstrate the relevance of EI approaches to natural resource management.

- **Modify and expand the definition and scope of Ecosystem Informatics, to incorporate various forms of modeling applied to natural resource problems.**
  In the IGERT renewal proposal we describe a framework for modeling that integrates statistical, simulation, and mathematical modeling approaches for ecosystem studies. Working within this EI framework helps EI research to transcend many limitations of current modeling for natural resource problems, which is often arbitrary and not repeatable.

- **Provide continuing faculty commitment to educating students at OSU at all levels (undergrad and graduate) in Ecosystem Informatics.**
  The four junior faculty hired through the Provost Initiative (Matthew Betts, Vrushali Bokil, Xiaoli Fern, Yevgeniy Kovchegov) as well as a fifth whose participation was donated from computer science (Wong) are making major contributions to educating students in their home departments and in interdisciplinary teaching on the OSU campus.

- **Remain recognized as primary place in the US for graduate education in ecosystem informatics.**
  Our program is increasingly recognized as the place to study ecosystem informatics nationally.

- **Extend the concepts of Ecosystem Informatics education into undergraduate education.**
Our faculty (Bokil) offers an undergraduate honors class (Mathematical Ecology) that extends the concepts of ecosystem informatics to undergraduates. A comparable course is planned to be offered by Computer Science.

**Specific Goals**

- **Establish a Center for Mathematical Modeling and Computations in the mathematics department to support and strengthen the research side of Ecosystems Informatics and other related interdisciplinary activities linking science, engineering, agriculture and forestry.**

  This goal was not accomplished, in the sense of a formal center. However, the collaborative relationships between mathematics, computer science, natural resources, ecosystem science, and geosciences established under the EI strategic initiative will live on beyond the initiative funding and have led to many research proposals, including $10 million of funded work in computer science.

- **Establish an engineering center at OSU that merges sensor design with the elements of the ecosystem informatics approach.**

  This goal was not accomplished, in the sense of a formal engineering center proposal. However, the collaborative relationships between mathematics, computer science, natural resources, ecosystem science, and geosciences established under the EI strategic initiative are resulting in active collaborations on miniaturized sensors and sensor networks, with a major focus on machine learning.

- **Promote Ecosystem Informatics through journal papers, Wikipedia, and international conferences.**

  PhD students and faculty in the EI initiative published over 200 papers in the five years of the initiative funding, and made dozens of presentations at national and international conferences. A Wikipedia entry on Ecosystem Informatics describes the programs at OSU, and these are the first links listed when searching online using the term ecosystem informatics.

- **Prepare all 5 Assistant Professors for tenure with funded NSF grants, graduate students, publications, and successful mid-term (3-yr) reviews.**

  The four junior faculty hired through the Provost Initiative (Matthew Betts, Vrushali Bokil, Xiaoli Fern, Yevgeniy Kovchegov) as well as a fifth whose participation was donated from computer science (Wong) are making good progress toward tenure. As of August 2009, the new math faculty members hired under the provost initiative (Bokil, Kovchegov) were undergoing pre-tenure reviews, and the Chair of Mathematics (Dennis Garity) indicates that Vrushali Bokil is 100% on track for tenure, while Yevgeniy Kovchegov is very strong in research with some minor concerns about teaching. The new forestry faculty member (Betts) will have his pre-tenure review in the 2009-2010 academic year, and the Chair of Forest Ecosystems and Society (Brenda McComb) writes. “Matt Betts is making excellent progress toward a positive tenure decision. He will be going through a mid-term evaluation this next academic year. He is author or co-author on 23 refereed publications, 10 since coming to OSU. He also has accumulated over $800,000 in external grants and contracts to support his work. His graduate level course in Landscape Ecology received perfect (6.0) SET scores and his SET scores for the informatics courses were also excellent. Last term he taught a large undergraduate course serving over 80 students from FW, FM, and NR majors among others. He is on an excellent trajectory for success in his career at OSU.” Of the new Computer Science faculty members (Fern, Wong), Fern will have a pre-tenure review in 2009-2010 (the Chair of EECS, Bella Bose, wrote that Fern delayed her tenure clock), while Wong had a successful midterm review, in which he was told that he is on track and should increase the number of publications
with his students and work toward being lead PI on a grant (he has been lead PI on 2 NSF proposals, one of which is still in review).

- **Obtain a steady stream of 5-10 graduate students/yr takingEI minor at OSU.**

  The demands of ecosystem informatics are sufficiently high, and the field sufficiently new, that students still require fellowship support to engage in this area of work. As a result, the courses in the Ecosystem Informatics minor do not have high enrollments. We submitted a renewal IGERT proposal to NSF in October 2008, which came very close to being funded, but was ultimately declined. With the encouragement of our External Advisory Board and other PIs who have received NSF IGERT renewals, we are planning on attempting another renewal again in 2010.

- **Extend the Ecosystem Informatics summer institute to OSU students in engineering, forestry, agriculture, and science.**

  Under the leadership of Desiree Tullos, Julia Jones, Tom Dietterich, and Enrique Thomann, the Ecosystem Informatics summer institute has trained a total of 43 students (13, 14, and 16) in the summers of 2006, 2007, and 2008. About 10 of these students are OSU students, including several in mathematics and several in forestry.
3) Updated metrics from previous annual reports.

- **Goal 1. Hire four tenure-track Assistant Professor faculty members to conduct collaborative research, teach and advise graduate students pursuing minor in ecosystem informatics**

All four Assistant Professors from the Provost Funds are now actively involved in our Ecosystem Informatics (EI) IGERT. In addition Weng-Keen Wong, Assistant Professor in Computer Science, who is not funded by provost funds, has co-taught our spring 2007/08 and 2008/09 core Ecosystem Informatics IGERT class GEO 547 COLLABORATIVE RESEARCH IN ECOSYSTEM INFORMATICS. Multiple collaborative research proposals have been prepared and several have been funded.

The remaining four fellowships for 2008-09 were high caliber students who are being advised/mentored by the four new faculty hired under the strategic initiative.

- **Goal 2. Increase diversity of faculty and student body at OSU**

We continue to strive towards this goal as illustrated in the EISI (Eco-Informatics Summer Institute). Of the 13 students who participated in this the first year (summer 2007)

  61% are female

  13% are Native American

  13% are Hispanic

One Hispanic student was directly recruited from the SACNAS (Society for Advancement of Chicanos and Native Americans in Science) conference in Tampa Bay, FL (Oct. 2006) by the Ecosystem Informatics Assistant Director. Our vision is to groom these students, who are undergraduates and early career graduate students, into our Ecosystem Informatics PhD program and/or minor and other relevant PhD programs at Oregon State University.

In summer 2009 of the 16 students coming in, 3 are minority. This is our strongest group ever with many students coming from first rate colleges and universities.

We continue to mentor young faculty hired by the Provost’s Initiative and deeper collaborative connections. Of the four new hires 50% are female, 50% are Asian, and 50% are International Scholars.

Our principal goals in the Ecosystem Informatics Provost Initiative have been to strengthen and diversify the OSU faculty, integrate new faculty, improve the quality and diversity of students, achieve national and international recognition for our graduate program in Ecosystem Informatics, and engage stakeholders.
Goal 3. Create an ecosystem informatics education program that is permanent and open to all graduate students at OSU

In December 2006 our Ecosystem Informatics minor was approved and made available to all students who have graduate student status. Six students not on fellowship have taken the classes which constitute the minor over the period 2005-2009.

http://catalog.oregonstate.edu/MinorDetail.aspx?minor=6340&college=08

We also offered an undergraduate honors class in ecosystem informatics – Mathematical Ecology (taught by Vrushali Bokil in winter 2008) which drew students to both the EI IGERT program and the EISI (summer institute).

Goal 4. Recruit outstanding students to OSU

Our undergraduate summer institute at the HJ Andrews had 13 outstanding students in the summer of 2007 from institutions including Reed, Stanford, and CalTech; some of these students will be continuing to work on thesis projects with OSU faculty during the academic year. In summer 2008, we had 14 students, and in summer 2009 we have 15 students, including students from Brown University, Dartmouth, Wesleyan, etc.

In comparison to other graduate students those who are participating in the Ecosystem Informatics program are exceptional. Some highlights which occurred during the 2008-09 academic year are illustrated below.

- For the fifth year, Ecosystem Informatics IGERT students from all five cohorts, IGERT PIs, and many faculty advisors joined together in the annual boot camp experience, a five-day field course at the magnificent old-growth forest and stream ecosystems of the HJ Andrews Experimental Forest and NSF-funded LTER site. The boot camp involves visiting study sites where long-term ecosystem experiments are underway, and discussing the ecological mathematical, computer science aspects of the work underway. This year we visited long-term watershed experiments, a 200-year log decomposition experiment, and a fire tower, and discussed mathematical and computer science problems involving ecosystem fluxes.

- IGERT students collaborated in team projects integrating machine learning, applied probability, and mathematical models to the study of selected ecological problems. Students are grouped into teams of one or two ecologists, one computer scientist, and one mathematics student and they are supervised by a team of faculty (ecologist, computer scientist, and mathematician). Their work is presented as a written report and an oral presentation with feedback from other teams.

- Ecosystem Informatics IGERT trainees learn to use machine learning methods suitable for ecological problems. This year they focused on Bayesian networks and Hidden Markov Models, including problem definition, model formulation, and solutions using Genie.

Several of our students were first authors on publications with their internship mentors, advisors and other collaborators. A few of these examples are below. For a composite list of Ecosystem Informatics publications, please visit: http://ecoinformatics.oregonstate.edu/new/pubs.html
Goal 5. Create collaborations among senior and junior faculty across ecosystem informatics disciplines at OSU

In 2008-09

- Faculty increased their participation in non-home-discipline meetings, conferences, and similar activities.
- Faculty are participating on multidisciplinary dissertation committees more often.
- Faculty are jointly authoring papers across disciplines more often.
- Faculty are members of multidisciplinary teams winning new grant support more often. In 2008-09, four collaborative research proposals (not counting the IGERT renewal) were submitted to NSF by EI faculty including the young faculty supported by the Provost Initiative; two of these were almost awarded funding; one is still under consideration. CS collaborators were awarded a very large grant to study species mapping.

Goal 6. Leverage the strategic initiative funding and the NSF IGERT funding to submit additional extramural funding

The Provost’s Initiative has helped solidify our program with faculty hires.

Goal 7. Contribute to the definition of the emerging field of Ecosystem informatics through conference presentations and journal articles.

Faculty have continued to make presentations and publish at very high rates, see http://ecoinformatics.oregonstate.edu/new/pubs.html

Goal 8. Conduct self-evaluation and external evaluation of the success of the Ecosystem Informatics program and devise appropriate changes

On May 15th and 16th, 2009 we conducted our Fourth Annual Retreat in the Memorial Union where five External Advisory Board members from academia and institutions in the U.S and Canada evaluated our program. This report is available upon request.
4) Other helpful information (examples from the past include student credit hours that have been/could be generated; new dollars that will be generated from the dollars that have been invested; etc.). It will be important for us to be able to communicate with the campus community how these strategic investments have paid off for the University.

The Strategic Initiative’s support of the new Assistant Professors has seeded the following in 2008-09:

● student credit hours (6 to 12 graduate students in each of 4 courses);
● 4 NSF proposals and one foundation proposal in this past year;
● publicity on EI activities

  o Computer science careers in Ecosystem Informatics, Tapia Celebration of Diversity in Computer Science, 04/01/2009 PIs (Dietterich, Jones) hosted a session at the Tapia Celebration of Diversity in Computer Science meeting in April in Portland to present Ecosystem Informatics to minority CS students.

  o Congressional testimony, US Congress, 03/01/2009, IGERT PI (Harmon) testified about carbon and climate change to the US Congress; covered in many daily papers and NPR.

  o Eco-informatics education and native people, Winds of Change, 07/01/2008, EISI (undergraduate recruitment pipeline for the IGERT) was featured in Winds of Change, a national magazine with a focus on career and educational advancement for Native people. Desiree Tullos (faculty advisor in the IGERT) was interviewed.

  o Expert testimony to Oregon Department of Forestry, Oregon Department of Forestry, 01/01/2009, Janine Rice (IGERT trainee) gave presentations to the Oregon Department of Forestry about sustainable harvest levels using modeling.

  o NRC report, Hydrologic effects of a changing forest landscape, National Academy of Sciences,11/01/2008,The National Academy Press issued the report and press release; Jones (PI) was vice-chair. Report also was featured in NAS press release from Obama’s speech of April 2009.

  o Oregonian article about forests and water, Oregonian newspaper, 10/19/2008, Jones (PI) interviewed about forests and water, see: http://www.oregonlive.com/environment/index.ssf/2008/10/the_secrets_out_tons_of_water.html.
5) A budget summary for your initiative.

FY 2008-09

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