PROPOSAL FOR
COLORADO STATE UNIVERSITY
PROGRAM OF RESEARCH AND SCHOLARLY EXCELLENCE

November 1, 2003

1. *Name of the nominated program. The term "program" means a concentration, department, center, institute, etc., and can involve a single discipline or be multidisciplinary.*

Natural Resource Ecology Laboratory
College of Natural Resources

2. *Name(s) of the faculty members associated with the program. Faculty members may be designated "core" and "affiliate" if that is appropriate. Provide documentation of honors and distinctions of faculty in this section.*

The Natural Resource Ecology Laboratory (NREL) has 65 Research Scientists as members (there are no 'faculty' as this is a 'soft money,' non-academic research unit). Research Scientist membership consists of 25 core, 23 non-core, and 17 affiliate Research Scientists. As described in more detail below, core scientists are defined as those with active externally funded research projects. Along with the core scientists, non-core and affiliate scientists collaborate actively in ongoing research programs and participate in the overall scientific life at NREL, as well as NREL administrative and scientific decision making. The research science community at NREL represents one of the most distinguished collections of ecosystem scientists in the world. Among our members we include former presidents of the Ecological Society of America and the American Institute of Biological Sciences, program officers at the National Science Foundation (NSF), chairs and panel members of numerous National Academy of Sciences committees, fellows of scientific societies, and panelists for funding agencies. The NREL core and non-core Research Scientists contribute to multidisciplinary intellectual interactions; lead or participate nationally and internationally on complex, integrated research collaborations; publish multi-authored papers resulting from NREL's atmosphere of trust and collegiality; mentor and provide hands-on training for young scientists (post docs), graduate students, and undergraduates from Colorado, the nation, and countries around the globe. Most NREL core and non-core Research Scientists use the NREL facilities daily and call NREL their primary administrative unit. NREL core scientific members serve as principal investigators on collaborative research involving other scientists from CSU, other universities, and federal, state, and non-governmental agencies and scientific staff. In addition, six internationally renowned scientists, three from the United States Geological Survey and four retired, are active core members engaged in research and mentoring, and are housed at NREL. Of the 65 NREL members, 22 are housed in academic departments at CSU, on other campuses, or at federal research institutes. The NREL affiliate members have voting privileges on internal matters and actively participate in ecosystem research at NREL. The NREL employs an average of 100 people per year. Research Scientists, through their competitive grant funding, currently support and house a professional support staff of 61 research associates (including a full-time lab manager, computer support personnel, post-doctoral fellows), 9 administrative staff, 43 graduate students, and many undergraduate research assistants.

The Natural Resource Ecology Laboratory Research Scientists

***Core* Research Scientists**

Baron, Jill S.; Boone, Randall B.; Conant, Richard; Coughenour; Michael B.; Elliott, Edward T.[2]; Ellis, James E.[2]; Galvin, Kathleen A.; Gross, John[3]; Hanan, Niall; Hobbs, N. Thompson; Hunt, H. William[1]; Kalkhan, Mohammed; Milchunas, Daniel; Ogle, Stephen M.; Ojima, Dennis S.; Pagani, Mark[3]; Parton, William J. [1]; Paul, Eldor A.[1]; Paustian, Keith H.; Singer, Francis J.; Six, Johan W.[6]; Slusser, James; Stohlgren, Thomas; Swift, David M.[1]; Theobald, David M.; Wall, Diana H.; Welker, Jeffrey M.

***Non-Core* Research Scientists** Adams, Gina A.[3]; Bigelow, David[2]; Broos, Emma; Chong, Geneva; DelGrosso, Stephen; Fahnestock, Jace[3]; Gao, Wei; Hicke, Jeffrey; Landrum, Laura; Lubow, Bruce C.; Manier, Daniel; Merritt, David[4]; Neff, Jason[3]; Nkem, Johnson; Parsons, Andrew[3]; Porazinska, Dorota[3]; Ratnam, Jaysharee; Reid, Robin[4]; Sankaran, Mahesh; Simmons, Carol L.; Togtohyn, Chuluun[3]; von Fischer, Joe[5]; Wang, Guiming

***Affiliate* Research Scientists** Binkley, Daniel E., Forest Sci, CSU; Burke, Ingrid C., Forest Sci, CSU; Cole, C. Vernon[1]; Covich, Alan P., Fish & Wildlife, CSU; Detling, James K., Biology, CSU; Gibson, James H.[1] Hautaluoma, Jacob E., Psychology, CSU; Holland, Elisabeth, NCAR; Kittel, Timothy G.F., NCAR; Lauenroth, William K., Rangeland Ecosystem Science, CSU; Moore, John, Univ. Northern Colorado; Mosier, Arvin R., USDA-ARS; Peters, Debra P., USDA-ARS/NMSU; Pielke, Roger, Sr., Atmospheric Sciences, CSU.; Sanford, Robert L., Jr.,; Univ. Denver; Schimel, David S., NCAR-CU; Woodmansee, Robert G., Rangeland Ecosystem Science, CSU.

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[1]retired, [2]deceased, [3]left CSU since 7/1/1998, [4]located other than NREL, [5]arrived after 7/1/03, [6]location, UC Davis, has part-time CSU appointment.

3. Describe how the program fits Colorado State University's role and mission.

The Natural Resource Ecology Laboratory exemplifies the land grant mission of Colorado State University (CSU). Our mission is "to ensure the sustainability of the Earth's ecosystems through the generation and application of new knowledge." Our interdisciplinary, ecosystem research promotes collaborations among disciplines and across fields of expertise at CSU and throughout the world. This mission motivates our research to address complex environmental problems facing society. Our research focuses on understanding how human activities impact local, regional, and global environments.

Our interdisciplinary ecosystem approach leads to a teaching paradigm that promotes intellectual engagement of academic topics in a novel cross-disciplinary fashion not expressed in standard departmental courses. This approach also provides the opportunity for teamwork among students and researchers at the NREL, and in so doing, fosters interdisciplinary interactions. We believe this working style is fundamental in solving complex environmental problems. Our students also gain practical skills and learn theory through the use of state-of-the-art instruments and analytical tools used in ecosystem research. We mentor outstanding students and launch them successfully into careers of research, education, and public service. The knowledge gained in our research is shared among many user communities that extend from K-12 education through northern Colorado, to state and federal agencies, and to governments and non-governmental organizations worldwide. This outreach and extension service benefits NREL and CSU by enhancing linkages between society and the fundamental research studies being conducted by our students and faculty. These additional insights related to societal needs and questions have been translated into various successful research studies, and complete the valuable circle of enquiry we seek among our students and staff.

4. Provide evidence of state/national/international recognition for excellence.

The Natural Resource Ecology Laboratory has achieved a high level of recognition across the state of Colorado, nationally and internationally. NREL scientists receive honors and awards for their contributions to ecosystem science, provide critical input to national and international research strategies for the current millennium, and are recipients of distinguished awards.

NREL scientists received more than 26 major awards for professional achievement during 1998-2003. Several of these are particularly notable. Diana Wall was elected as an AAAS Fellow and Aldo Leopold Leadership Fellow, served as chair of the Council of Scientific Society Presidents, and served as President of the Ecological Society of America. Dennis Ojima and Kathy Galvin were also Aldo Leopold Leadership Fellows (only 60 have been selected in 5 years). Tom Stohlgren received a USGS Special Achievement Award for establishing the new USGS National Institute of Invasive Species Science and developing long-term partnerships with NASA, and also received the Star Award for leadership in bringing the science of invasive species to the National Refuge System. The Department of Interior recognized Jill Baron with a 2002 Meritorious Service Award for her work on atmospheric deposition. She was also elected to the Ecological Society's Governing Board as secretary. The Society of Photo-instrumentation Engineers International Society for Optical Engineering awarded Jim Gibson, former NREL Director and affiliated NREL Research Scientist, the prestigious Career of Excellence Award in Network Design and Instrument Development in UV Radiation. David Theobald was awarded the Nature Conservancy's David H. Smith Fellowship in Conservation Research.

NREL scientists contributed to scientific activities by serving in scientific organizations, on panels and review boards, and by presenting research findings. During 1998-2003, NREL scientists served on editorial boards for nine international peer-reviewed journals, including the top journals in their fields (e.g., *Applied Soil Ecology, Ecology, Oecologia, Global Change Biology, International Journal of Meiofaunal Zoology, Ecosystems, Ecological Monographs, Ecological Applications, Journal of Geophysical Research,*). It is particularly noteworthy that four NREL scientists served on the editorial board of *Ecological Applications*, a top peer-reviewed publication in the field of ecology. Eight NREL members participated in committees within national and international scientific societies (one chair) during 1998-2003.

NREL scientists have served on 15 national and 2 international panels. These national panels included six prestigious National Academy of Science assignments that addressed topics of national and international significance. Diana Wall chaired two National Research Council panels (Valuation of Biodiversity; Scientific Committee on Problems in the Environment). Dennis Ojima co-chairs the International Geosphere Biosphere Program/International Human Dimensions Program (IGPB/ IHDP) Land Transition Committee. Other invited participations included the NRC panel to review ungulate management in Yellowstone National Park (Gross); the NSF panel on Biocomplexity in the Environment, and the USGS Venture Capitol Funds Competition Panel (Baron); NSF Ecosystems Studies Program Review (Coughenour); NASA's Large-Scale Biosphere-Atmosphere Experiment in Amazonia Ecology Review Panel (Hanan); USDA Forest Service Haman Fire Science Review Panel (Theobald); and the NSF Advisory Panel for the Ecology Program (Hobbs). Keith Paustian was lead author of the IPCC Good Practice Guidelines for Land Use: Land Use, Land Use Change and Forestry. Paustian also briefed U.S. Congressional staffers, U.S. Lead Climate Change Negotiators, and senior administration officials on Climate Change and Agricultural Mitigation of Greenhouse Gases. Ojima, Baron, Stohlgren, and Paustian were major contributors to the 2000 U.S. National Climate Change Impacts Assessment, organizing and leading the analysis for regional and sectoral components of the National Assessment. Many NREL scientists participated in regional assessments (e.g., the Great Plains, the Rocky Mountains). Jim Slusser was a contributing author to the World Meteorological Organization Ozone Assessment chapter on UV-B measurements.

Scientific advances are often driven by intensive exchange at topical workshops or training sessions, and in 1998-2003, NREL scientists organized 21 of these events. These workshops included contributions from nationally and internationally recognized experts on greenhouse gases, carbon dynamics in soils, soil biodiversity, ecosystem stability, ecosystem response to UV-B radiation, and management of grassland ecosystems.

Publications for 1998-2003 (see Appendix I)

NREL has firmly established itself as a significant contributor to scientific literature in various fields of ecology. NREL scientists published a total of 418 peer-reviewed papers in national and international scientific journals. This rate of publication is equivalent to approximately 2.6 papers per author per year, but this value is variable across years and scientists. The rate of publication (defined as number of peer-reviewed publications listed in the ISI Web of Science database, which does not include books, book sections, or conference proceedings) was slightly greater than that of the previous period. NREL scientists have also produced 3 books, 35 invited book chapters, and many peer-reviewed conference proceedings (not listed). Additional publications by NREL scientists reach a broader audience through various government reports, web sites, etc. (e.g., NDIS, www.ndis.nrel.colostate.edu).

The papers published by NREL scientists continue to have an impact in their respective disciplines, receiving an average of 97 citations per year per scientist. This average represents approximately 12 citations per paper per author. In April 2003, Thompson-ISI published the list of the top 250 most cited authors in 21 categories (ISIHighlyCited.com). Nine CSU scientists were included in the lists for four categories. Six of these nine scientists are core or affiliate members of NREL (C.V. Cole, J.K. Detling, W.K. Lauenroth, W.J. Parton, E.A. Paul, and R.A. Pielke). In the Ecology and Environment category, three NREL core scientists were listed: E.T. Elliot (listed under his last affiliation at the Univ. Nebraska, 1318 citations), W.J. Parton (3087 citations) and E.A. Paul (1262 citations), as well as an affiliate member (D.S. Schimel). Inclusion on this list is a significant indication of the importance of the work generated by NREL scientists. ISI describes their lists as comprising "less than one-half of one percent of all publishing researchers - truly an extraordinary accomplishment."

5. *Describe the impact of the program on undergraduate and graduate education and training, including graduate student graduation rates of the past five years. Provide information about the placement of graduates of the program.*

The Natural Resource Ecology Laboratory scientists consider the education and training of young scientists (post-graduate [M.Sc., Ph.D.], graduate, undergraduate, and K-12 students), high school teachers, natural resource managers, the public, and policy makers a top priority. Conveying information about the cutting-edge ecological research necessary for solving multi-dimensional environmental problems is a responsibility to society's global future, and is thus an important component of our mission. Although we receive no academic funding support permitting us to teach or track our graduate students who receive degrees from many other departments, or to support computer or analytical laboratory facilities that are used in training these students (we rely on overhead return based on our grant success), our commitment is strong. NREL scientists contributed their own money to establish the NREL Scholarship Award which benefited seven students from 1998 until this year when funds were depleted.

During the last 5 years, 236 CSU undergraduates, 143 foreign students, visitors, and other employees were supported on an hourly basis on 137 projects. NREL scientists advised 84 graduate students of which 46 have graduated, 34 are current, and 4 have left the program. Only 18 were self-

funded (fellowships or external stipend) while the remainder were supported by NREL projects Appendix II. Some students have been awarded prestigious fellowships, such as the Canon National Science/Scholar Award which Koren Nydick received from the National Park Service in 1999. Beyond traditional graduate training, students affiliated and housed within NREL learn in a challenging, interdisciplinary setting which shapes their scientific thinking. Undergraduate and graduate students gain experience at NREL working with mentors and large research teams, conducting analyses that bridge disciplines, collecting field data, and assisting other graduate students. Students and young scientists (Ph.Ds) conduct field work on every continent and from pole to pole with NREL research support. For example, many conduct their research in remote areas of Mongolia, Kenya, Tanzania, Antarctica, Greenland, and South America, and most are active in environmental-human linkages that define policies (e.g., Kyoto and Global Change). NREL graduate students also receive training in the use of cutting-edge instrumentation, such as mass spectrometers and advanced computing facilities, to address ecological questions. Some make connections to international policy by contributing to research projects at NREL, such as the International Biodiversity Observation Year 2001-2002, and in gathering global data sets, such as the Agroecosystem Greenhouse Gas database and the Natural Diversity Information Source (NDIS). NREL graduate student alums have demonstrated high levels of scientific achievement as indicated by their publications in leading scientific journals, invited presentations at national meetings, and prestigious research and achievement awards.

NREL contributes formally and informally to education at CSU. More than 20 courses are taught each year by NREL scientists. Our scientists also regularly guest lecture in departments throughout CSU. In 1999, 27 courses were taught by NREL scientists to a total of 934 students, and in 2001, 21 courses were taught to 1620 students. Over 20% of these courses were taught on a voluntary basis. Nine additional short courses in ecological modeling and spatial analysis techniques trained 93 national and international students. Currently, NREL core scientists advise 41 graduate students, but students from nine departments in five colleges benefit from interactions with NREL scientists. Today, over 100 graduate student committees include NREL core members. Since 2000, NREL affiliate and former Director Bob Woodmansee developed five on-line educational courses.

The NREL Research Scientists contribute substantially to the success of the Graduate Degree Program in Ecology (GDPE). From 1998-2003, NREL scientists advised 49% of students receiving degrees from GDPE. NREL scientists comprise almost one-quarter of the GDPE faculty. NREL scientists serve on GDPE and other standing academic committees, contributing further to the educational mission of GDPE and CSU. During the 2002 academic year NREL scientists taught five of ten courses offered by GDPE (EY courses).

Graduate students supervised by NREL personnel always find employment upon graduation, typically in research, academic, and scientist positions in leading institutions and agencies. In 2002, for example, all graduates were hired as assistant professors or to lead in research projects at universities or federal labs. Former NREL students are now at the Univ. New Hampshire (Serita Frey, GDPE 1999: Ted Elliott, advisor), Creighton Univ. (Amy Treonis, GDPE 1999; Wall, advisor), Univ. Wisconsin (Chris Metzger, GDPE 2002; Mike Coughenour, advisor), Iowa State Univ. (James Miller; Tom Hobbs, advisor), and the National Academy of Sciences (Margaret Walsh, GDPE 2002; Dennis Ojima and David Schimel, advisors).

NREL's intellectual contributions to understanding complex systems are recognized globally and bring an impressive array of young and established scientists to NREL to gain experience in ecosystem modeling, spatial analysis techniques, analytical methods, and to advance their own knowledge for research projects. For example, Brazilian graduate student Silvio Ferraz learned landscape analysis techniques with NREL scientist David Theobald and works to conserve Brazilian rain forests; Mrigesh Kshatriya, a scientist with the International Livestock Research Institute, studied integrated assessment and the ecosystem model SAVANNA with Mike Coughenour and Randy

Boone to aid in management of East African conservation lands; and visiting graduate student Petra Tschakert worked with Bill Parton, Steve DelGrosso, Dennis Ojima, and programmer Cindy Keough using the ecosystem model CENTURY to understand carbon cycling throughout Senegal. Besides learning techniques and tools used by NREL scientists to unravel complexity, visitors are exposed to the unique interdisciplinary approach to research used at NREL.

The NREL Research Scientists, staff, and students educate well beyond the CSU campus. A NSF grant with NREL and others at CSU and UNC (including John Moore, NREL affiliate Scientist), entitled "Colorado Front Range GK-12," funds NREL graduate students working with scientists Dave Swift and Jill Baron to prepare teaching modules and introduce concepts to grade school children. For example, grade school students learned how to form and answer research questions during a visit to a local prairie dog town, with guidance provided by GK-12 graduate students. Every year children and adults explore the importance of biodiversity with NREL scientists at the Denver Museum of Nature and Science. NREL scientists are asked to teach and participate in educational scientific workshops nationally and internationally. For example, Tom Hobbs conducted a workshop on model selection at the Univ. Rhode Island, and Dennis Ojima and T. Chuluun led a training workshop in Ulaanbaatar, Mongolia on land use mapping and ecosystem modelling.

Citizens and decision makers from Colorado and beyond learn about their environments from a wide variety of lectures and events in which NREL scientists participate. NREL scientists teach in a range of venues from all-night camps at Foothills Mall to teach children about marine life, to informing Estes Park residents about how management decisions may affect their lands, to the testimony of Jill Baron before a special session of the U.S. Congress about acid rain in the western U.S. NREL scientists are frequently interviewed by the media, including some high-profile outlets, such as Tom Hobbs' appearance on the NBC Nightly News and the New York Times cover story that included David Theobald. The three NREL Aldo Leopold Leadership Program Fellows received training in communication to the media, the public, and to Congress. Lastly, NREL scientists contribute greatly to literature used in education. "*Rocky Mountain Futures, An Ecological Perspective*," edited by Jill Baron, is an example of a recent volume that will impact decision making for years to come, and David Theobald's textbook on geographic information systems (GIS) is used in courses at nearly 50 colleges and universities across North America. NREL staff, students, and scientists quantitatively analyzed NREL water, energy, and carbon use to determine "The NREL Environmental Footprint: Resource Use at the Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, Colorado" and developed alternative strategies in consultation with CSU Facilities Management, for which Mark Easter received a 2002 CSU 'Campus Sustainability Award' from the Center for Teaching and Learning. NREL hosts a well-attended seminar series; as an example, the 2002 series on "Future Directions in Global Ecosystem Science" was exemplary in bridging to academic disciplinary faculty and students. NREL also hosts a biannual series featuring lectures by recipients of the prestigious NREL Excellence in Ecosystem Science award. Last year's awardee, Thomas Rosswall, Executive Director of the International Council for Science, Paris, France, is internationally renowned for his research. These events provide an opportunity for CSU and the public community to meet national and international leaders in scientific policy and ecosystem science.

6. Document the five year record of annual funding from external sources. Documentation should identify the name of Principal Investigator(s), collaborators, and students supported by the project(s).

NREL's total funding from external research over the period 7/1/98 – 6/30/03 was $42,357,275, an increase of 60% from the preceding 5-year period. The majority of funding comes from NSF (Appendix III). Overall statistics on proposals and awards for the 5-year period are presented in

Appendix IV. Total indirect cost (IDC) recovered was $6,635,484, an increase of 79% over the preceding 5-year period (Appendix V). NREL's operating budget averaged $375,000 per year during FY 99-03 and is solely from IDC return through the College of Natural Resources (CNR). It includes matching commitments by the College to NREL projects, but does not include the Director's salary. NREL scientists have been particularly successful increasing graduate student support and advising during FY 1999-2003. A sampling of local, national, and international collaborators on NREL funded projects is given in Appendix VI.

7. List and justify the three most appropriate peer programs.

NREL is most often compared with three other prestigious centers. The Ecosystems Center, Woods Hole, Marine Biological Laboratory (MBL) (Directors, Drs. J. Hobbie and J. Melillo), has 19 Ph.D. scientists, $0.27 M in core funding, and $7 M in grants and contracts. The Institute for Ecosystem Studies (IES), Millbrook, NY (Director, Dr. G. Likens), employs 28 Ph.D. scientists, has $3 M in core funding, and generates $5.5 M in grants and contracts (Drs. Likens and Melillo are NREL Advisory Committee members). Both of these institutions have endowments and are not affiliated with a university. The third peer institution is the Desert Research Institute (DRI), University and Community College System of Nevada (Director, Dr. J.S. Coleman). This center has 9 Ph.D. scientists, $0.28 M in core funding, and $3.2 M in contracts and grants. NREL's ratio of core funding (note: core funding for NREL is defined as overhead return) to grants and contracts is similar to MBL's (20 versus 26), higher than DRI's (11), and much higher than IES's (2). In terms of grant and contract dollars per Ph.D., NREL ($0.59 M) is less than MBL ($1.39 M) and DRI ($1.27 M), but greater than IES ($0.07 M; note that IES has over 50% funding from a private foundation).

NREL is a member of the Association of Ecosystem Research Centers (AERC), which includes 42 centers from academia, government laboratories, and private institutions. Of the 42 possible peers, we selected 18 for a comparison to NREL that had over 10 Ph.D. scientists and over $1 M in grants and contracts, and excluded government laboratories and academic departments. These peer institutions that obtain grant funding like NREL through a competitive peer- review process had an average of 26 Ph.D. scientists, received an average of $1.4 M annually in core funding (including money from universities and foundations), and generated an average of $4.7 M in grants and contracts. The mean ratio of grants and contracts to core funding was 5.5, and the mean amount of grants and contracts funding per Ph.D. scientist was $0.29 M. For comparison, NREL had 34 Ph.D. scientists, $0.34 M in core funding, and $6.8 M in grants and contracts. NREL's ratio of grants and contracts to core funding was 20, and the laboratory generated $0.59 M per Ph.D. scientist.

8. Describe the impact of the program on the economy of Colorado and the nation. Describe efforts made to encourage technology transfer and private sector development.

NREL's research, training, and education have direct and indirect impacts on the local, state, and national economy.

- Our annual expenditure for salaries is over $3 M and our total annual research expenditures are approximately $5.5M.
- Our research findings impact many private sectors critical to Colorado, including agriculture, energy production, greenhouse gas mitigation, tourism, information technology, and transportation.
    - Agricultural impacts include the development of ecosystem modeling and analytical tools (GIS techniques, climate, soil, land use management data sets) which have:
        a) increased the understanding of agriculture production and vulnerability,

b) assisted the development of best management practices to reduce environmental degradation while maintaining economic productivity,
c) fostered carbon sequestration potential and economic cost benefits, and
d) produced rangeland forage productivity estimates.

- Energy production impacts include the development of biofuel options, analysis of cost estimates of different farming systems including fuel consumption, a checklist for energy conservation, and cost reductions.
- Analytical tools and experimental research on greenhouse gas mitigation for urban and rural environments which can be adapted to public and private sector uses.
- Over 1000 visitors (person-days) come to NREL and Fort Collins for workshops, training seminars, research visits, and academic exchanges.
- NREL leads analyses, such as the way in which climate change will impact future Estes Park and Rocky Mountain National Park visitor/days, which is critical knowledge for the tourism industry.
- NREL analyzes elk, deer, trout, and other critical wildlife population and habitat changes which impact population sizes and distributions that ultimately affect the recreation and sporting industry.
- NREL is actively developing a grid computing infrastructure that will benefit the campus and the state by attracting high tech research and development that requires high speed computing.
- NREL spends $100k per year in air travel (including domestic and international travel).

9. *Describe the program's organizational structure, including reporting relationships to Unit Directors, Department Heads, and Deans.*

The Natural Resource Ecology Laboratory is a research unit within the College of Natural Resources. NREL's Director, Diana Wall, reports to the Dean and is a member of the College Executive Committee, along with the four CNR academic department heads. At NREL, the Director is advised by the NREL Executive Committee, ten members representing the diversity of Research Scientists at NREL. Every two years, NREL is reviewed by our prestigious External Advisory Committee, Dr. Norman Christensen, Jr., Dr. Thomas Lovejoy, Dr. James MacMahon, and Dr. Jerry Melillo, who meet with higher administration, department heads, deans, Experiment Station Director, and with groups of NREL staff, scientists, and students. This committee provides a review of the Director and NREL scientific research programs and administration

10. *Provide five (5) goals that the program expects to achieve in the next four years, including the human, physical and fiscal resources necessary to achieve them.*

I. CONTINUITY

Goal 1: *Diversify funding sources:* New and ongoing funding from external sources enables NREL scientists to conduct research at the cutting edge of ecosystem ecology, train students in innovative techniques to better understand ecosystem processes, and apply ecosystem knowledge toward solving environmental problems and sustaining natural resources. Obtaining this funding requires a major investment of scientist time and effort, but without immediate financial compensation. A relatively small amount of "bridge" funding would permit scientists to pursue numerous and diverse funding opportunities.

- Resources requested: a) Bridge funding (three months in each of the next two years) for new young scientists and senior scientists who are funded by federal grants; b) continued support from university administration for cost sharing; c) priority status for foundation fund-raising efforts.
- Return expected: a) Enable young scientists to jump start proposal writing; b) enable senior scientists to write private foundation grants (federal cost sharing presently prohibits this while scientists are funded on federal projects).

Goal 2: *Recognize and Support Mass Spectrometer Facility*: NREL recently acquired new inorganic and organic analytical laboratory equipment for the Colorado Laboratory for Environmental Mass Spectrometry (CLEMS). Purchased with contributions from the Graduate School, CNR, the College of Agriculture, and NSF, CLEMS continues to provide stable isotope analyses of biological and environmental samples.

- Resources requested: a) CLEMS be recognized and supported as a Campus-Wide Core Facility; b) expanded space to house the CLEMS; and c) bridging salary for a full-time mass spec technician for two years or earlier if grant funds are obtained.
- Return expected: Isotope biogeochemistry is becoming a standard tool for ecologists worldwide. Having a full-time mass spec technician will allow NREL and the university to attract outside funding for projects requiring isotope analysis of biological and environmental samples. The requested funding will assist scientists to remain competitive in obtaining grant money, and will allow NREL and other CSU students to be better prepared for career advancement.

Goal 3: *Increase computing capability:* Improving the NREL computing facility will help NREL maintain its leadership in ecosystem science computing and analysis. In addition to the traditional workstations and servers, scientists at NREL have contributed to building a Linux cluster with a set of 9 computing nodes consisting of 2 processors within each node, 1.6 Tbyte of dedicated storage, and a peak performance of 28 gigaflops. NREL has been supporting grid computing for two years and we are actively involved in the development of a campus grid (CSUGRID) and a statewide grid (COGRID). We will host a cell on the COGRID which allows us to leverage our resources for greater computing capacity as needed for research projects. In addition, NREL is advancing into the arena of serving large databases, such as greenhouse gas mitigation data sets for agricultural systems (TRAGNET/CASMGS), and the natural diversity information source (NDIS).

- Resources requested: a) An upgrade to the master computer nodes of the cluster; and b) expansion of the computation nodes and storage.
- Return expected: a) Researchers will be allowed to perform higher resolution ecosystem modeling simulations in less time; b) students and young scientists will be provided the opportunity to learn how to use high performance computing facilities; and c) campus-wide research will be supported by furthering grid technology.

II. FUTURE OF NREL

Goal 4: The rapid emergence and development of geospatial analysis as a fundamental component of ecological research makes it increasingly difficult for individual researchers to stay current in state-of-the-art techniques. We propose that NREL formally develop a research program in Geospatial Information, Analysis, and Modeling (GIAM, "jam") to consolidate expertise on geospatial technologies. By coordinating our expertise in GIS, remote sensing, and

statistical modeling, and by consolidating our personnel and software resources, GIAM will enable NREL to fully capture the emerging opportunities in global-, regional-, and landscape-scale assessments of ecosystems and biodiversity. It will also optimize our ability to pursue new research opportunities by supplementing scientists' research programs to include a spatial analysis component in future proposals. GIAM will also provide consulting services university-wide and to the local community (similar to the current Statistics Lab). We will also be poised to provide services to a broad array of natural resource agencies in anticipation of the large turnover in the federal workforce and to attract funding from foundations. The GIAM program has potential to become a Campus-Wide Core Facility and differs from COGSAM in that it is based around a core of actively-engaged researchers collaborating on cross-cutting projects, rather than a loose association of individual researchers.

- Resources requested: a) Four months of funding (total over two years) for a coordinator.
- Return expected: A coordinator skilled in geospatial technologies will: a) enable NREL to compete with other universities with this capability and thereby, attract federal funding in such diverse areas as land use change, desertification, climate change, ecosystem response to climate stress, and ecological forecasting; b) increase research funding levels; c) increase operational and personnel efficiency; and d) diversify funding sources.

Goal 5: *Global Environmental Sustainability Program (GESP)*. Finding sustainable solutions to today's environmental problems involves both science and society working together. Providing sound scientific information that can be used by decision makers, educators, and the public for the development of science-based strategies for sustainable resource use requires more efficient transfer of information between scientists and decision makers. The development and use of regional integrated analyses that incorporate the ecosystem and human dimension perspectives will provide this needed framework. This technology will be incorporated within an educational module focused on global environmental sustainability. We will focus on the development of regionally integrated analytical technologies to evaluate sustainable strategies at local to regional scales and to use this information to further develop educational materials to bridge across different aspects of the analyses.

- Resources requested: Organization and management of GESP will require three months salary for two years for an NREL scientist to provide leadership and a successful fund-raising strategy. Our first task will be to develop and implement intensive three to four week short courses on ecosystem sustainability tools for professional managers.
- Return expected: a) Funding resource will free and enable an NREL scientist to write proposals and conduct a GESP fund raising campaign to increase NREL's base of external private and international support; and b) offering short courses on ecosystem sustainability tools will lead to the development of a cadre of scientists who are successful in gaining outside support in this important growth area and will foster interaction among NREL scientists and managers working in locations that may be undergoing severe environmental change**.**

APPENDICES

I. Publications and Citations

II. Graduate Research Associates

III. Awards by Sponsor

IV. NREL Proposal and Award Statistics

V. Indirect Cost Recovery and Return

VI. Collaborators of NREL

VII. External Letters of Support

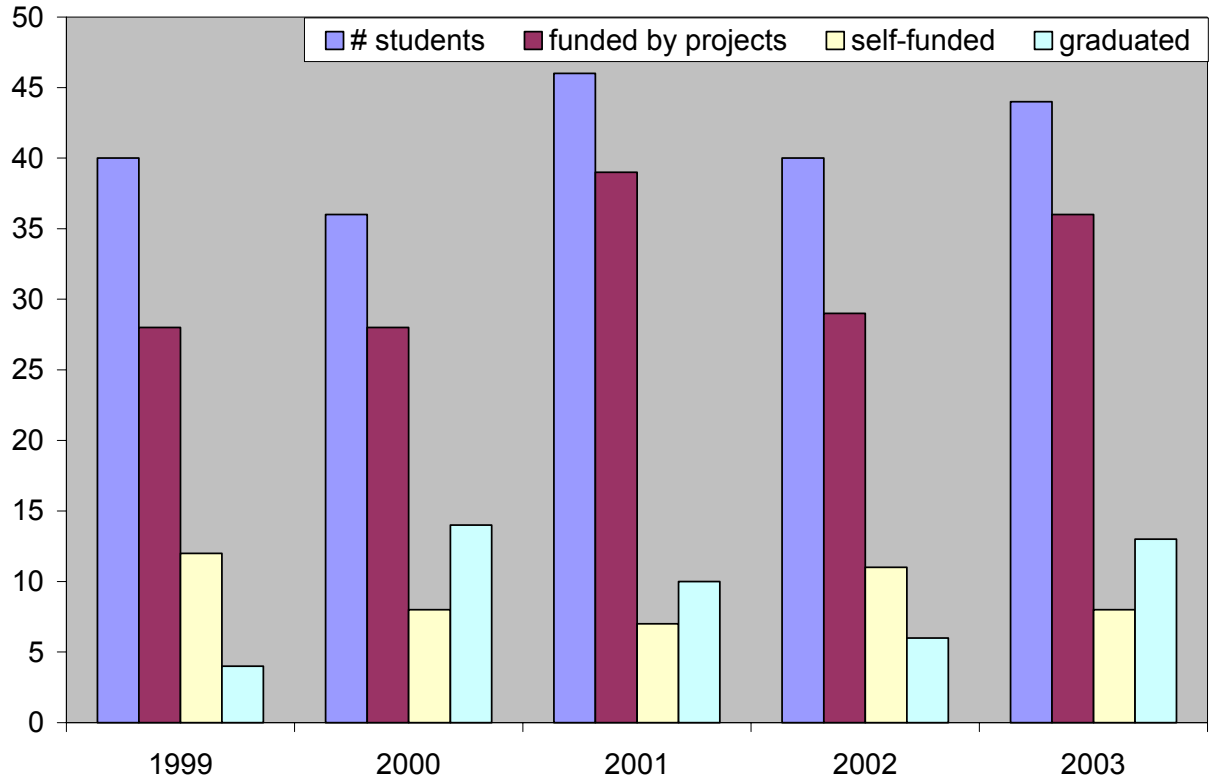
APPENDIX I-A. Peer Reviewed Publications for Core Scientists

	Yr of PhD	Acad age	< 07/01/98	1998	1999	2000	2001	2002	2003	Mean/year	Total
Baron	1991	12	6	5	3	9	3	2	5	4.5	27
Boone	1996	7	6	1	1	4	1	1	1	1.5	9
Conant	1997	6	2	1	0	1	1	3	2	1.3	8
Coughenour	1978	25	39	1	0	0	5	3	1	1.7	10
Elliott	1982	21	49	3	6	7	7	2	2	4.5	27
Ellis	1970	33	29	0	0	0	0	2	2	0.7	4
Galvin	1985	18	7	0	1	1	1	1	1	0.8	5
Gross	1990	13	14	1	0	2	2	1	1	1.2	7
Hanan	1990	13	14	1	1	0	1	2	0	0.8	5
Hobbs	1979	24	38	0	1	5	0	6	2	2.3	14
Hunt	1971	32	42	2	2	1	2	1	2	1.7	10
Kalkhan	1994	9	3	2	1	1	1	2	0	1.2	7
Milchunas	1991	12	25	3	3	1	2	4	1	2.3	14
Ogle	2000	3	0	1	0	0	0	2	1	0.7	4
Ojima	1987	16	33	4	1	3	1	3	3	2.5	15
Pagani	1998	5	0	1	5	3	1	6	1	2.8	17
Parton	1972	31	86	6	3	11	3	3	2	4.7	28
Paul	1958	45	97	2	3	6	4	4	6	4.2	25
Paustian	1987	16	19	5	7	7	8	10	4	6.8	41
Singer	1995	8	23	3	0	8	3	4	1	3.2	19
Six	1998	5	0	1	4	5	5	5	3	3.8	23
Slusser	1994	9	1	1	2	2	1	1	3	1.7	10
Stohlgren	1990	13	26	5	5	3	3	1	3	3.3	20
Swift	1985	18	32	1	0	2	0	0	2	0.8	5
Theobald	1995	8	3	0	0	2	2	1	1	1.0	6
Wall	1970	33	52	5	7	7	8	9	5	6.8	41
Welker	1985	18	23	3	6	6	0	1	1	2.8	17
Mean/person				2.1	2.3	3.6	2.4	3.0	2.1	2.6	
Total			669	58	62	97	65	80	56		**418**

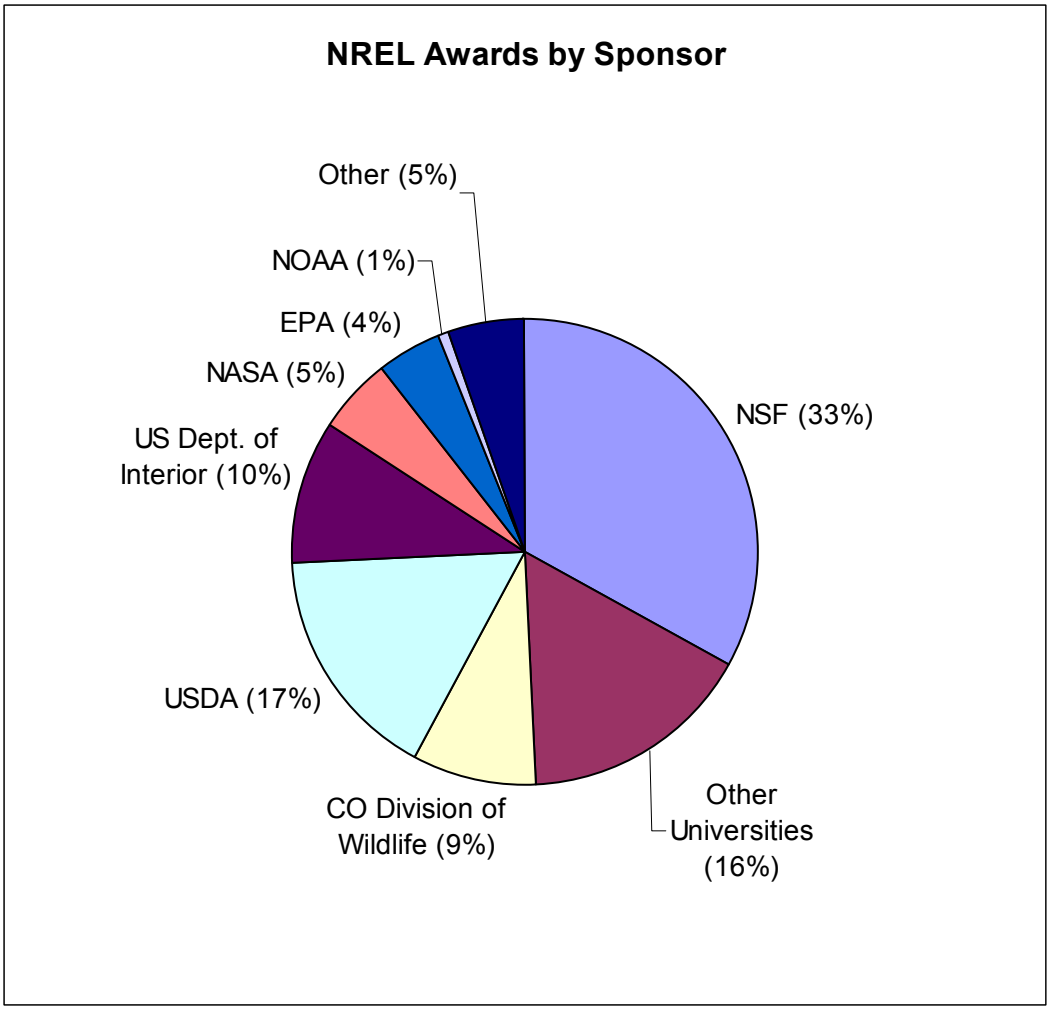
APPENDIX I-B. Citations: Results of a Sept. 2003 ISI search for NREL Core Scientists.

	Yr of PhD	Acad age	< 07/01/98	1998	1999	2000	2001	2002	2003	Mean/year	Total	Total/paper
Baron	1991	12	28	23	51	87	123	113	128	87.5	525	15.9
Boone	1996	7	12	4	2	5	4	18	10	7.2	43	2.9
Conant	1997	6	43	12	11	16	16	24	20	16.5	99	9.9
Coughenour	1978	25	681	110	102	115	87	94	75	97.2	583	11.9
Elliott	1982	21	1261	184	198	227	256	286	167	219.7	1318	17.3
Ellis	1970	33	600	52	70	61	55	54	34	54.3	326	9.9
Galvin	1985	18	22	6	8	14	9	14	5	9.3	56	4.7
Gross	1990	13	173	47	53	46	46	45	44	46.8	281	13.4
Hanan	1990	13	94	19	19	14	13	18	19	17.0	102	5.4
Hobbs	1979	24	556	107	83	103	99	123	112	104.5	627	12.1
Hunt	1971	32	1102	143	128	107	109	115	83	114.2	685	13.2
Kalkhan	1994	9	0	2	1	1	1	2	0	1.2	7	0.7
Milchunas	1991	12	334	108	104	121	119	146	68	111.0	666	17.1
Ogle	2000	3	0	1	1	0	2	3	2	1.5	9	2.3
Ojima	1987	16	825	263	249	324	308	315	215	279.0	1674	34.9
Pagani	1998	5	0	0	8	21	50	83	77	39.8	239	14.1
Parton	1972	31	1947	501	412	574	558	645	397	514.5	3087	27.1
Paul	1958	45	3133	176	166	214	234	283	189	210.3	1262	10.3
Paustian	1987	16	370	71	64	108	178	238	152	135.2	811	13.5
Singer	1995	8	173	49	31	57	70	54	42	50.5	303	7.2
Six	1998	5	0	0	4	25	51	82	48	35.0	210	9.1
Slusser	1994	9	0	2	6	4	16	24	16	11.3	68	6.2
Stohlgren	1990	13	109	25	35	81	108	96	87	72.0	432	9.4
Swift	1985	18	788	101	81	112	94	77	63	88.0	528	14.3
Theobald	1995	8	2	2	0	4	8	11	12	6.2	37	4.1
Wall	1970	33	540	131	201	174	207	275	174	193.7	1162	12.5
Welker	1985	18	248	63	103	90	90	112	71	88.2	529	13.2
Mean/person				81.6	81.1	100.2	107.8	124.1	85.6	96.7		11.6
Total			13041	2202	2191	2705	2911	3350	2310		**15669**	

APPENDIX II. Graduate Research Associates

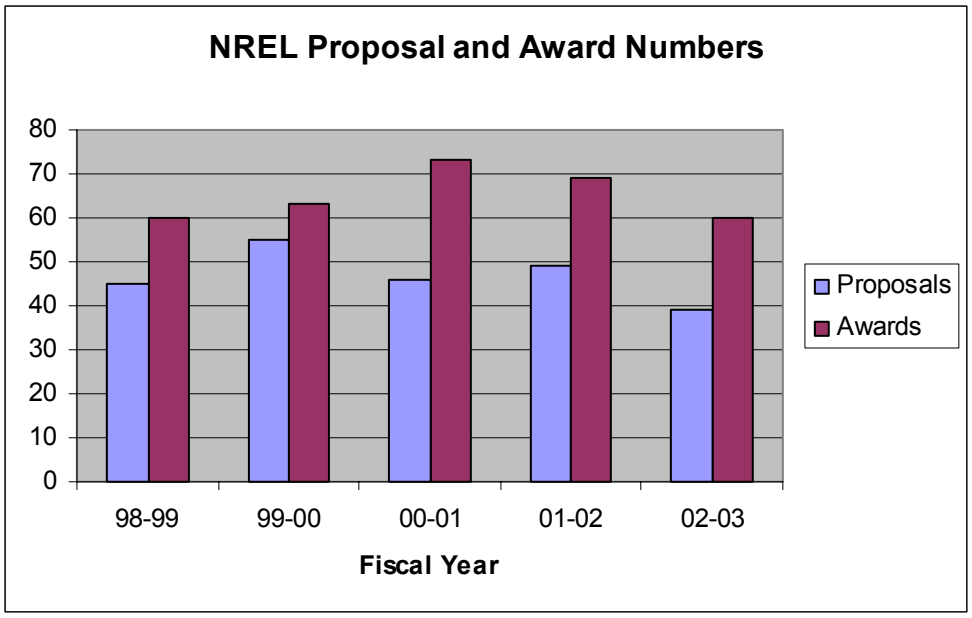


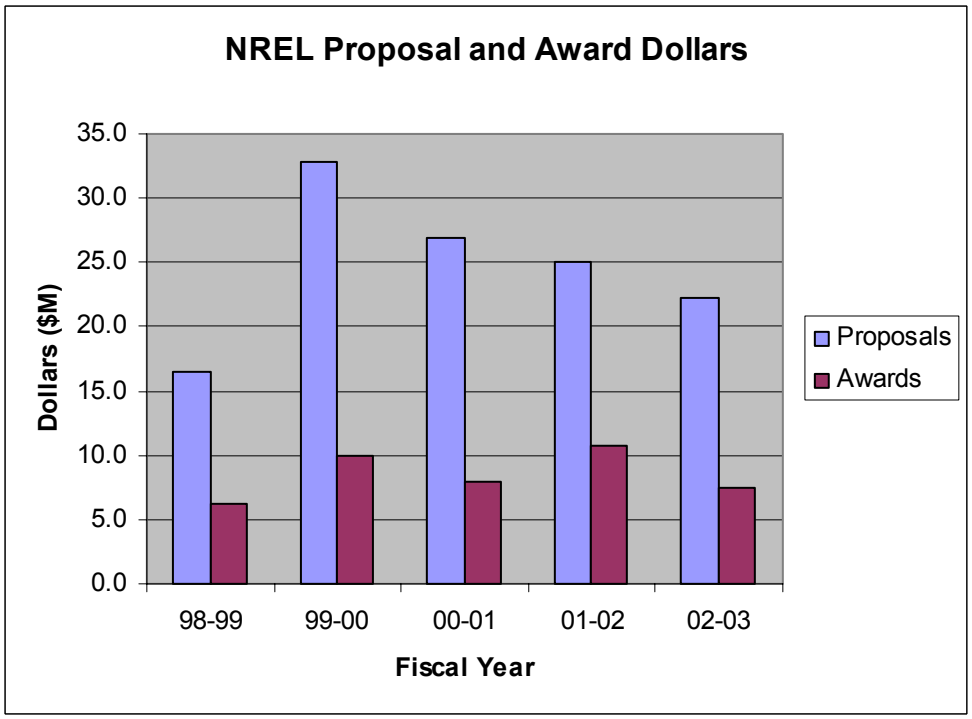
APPENDIX III. Awards by Sponsor



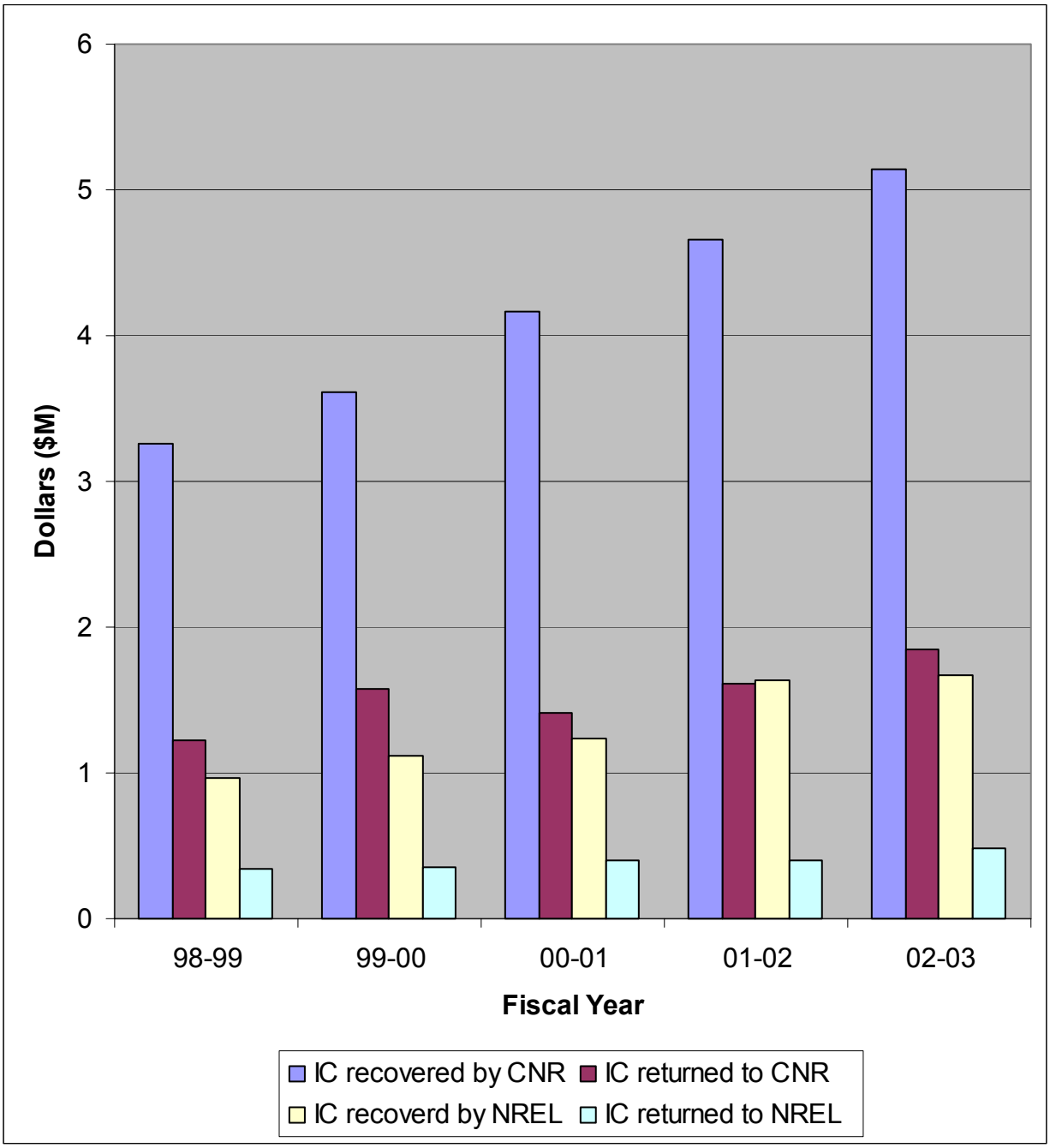
- Includes awards made from 7/1/1998 - 6/30/2003
- Total dollar amount of awards for the period = $42,357,275
- "Other Universities" includes subcontracts under prime federal grants from institutions such as the Univ. of Nebraska, Kansas State Univ., Ohio State, Univ. of California at Davis, Duke Univ., and many others.
- "Other" includes awards from DOE as well as a variety of foundations, and private sources
- "US Dept. of Interior" includes awards from the US Geological Survey the National Park Service, and the Bureau of Land Management

APPENDIX IV. NREL Proposal and Award Statistics





APPENDIX V. Indirect Cost Recovery and Return - CNR and NREL



APPENDIX VI. NREL Collaborators

NOTE: This list is only a representative sampling of local and international NREL collaborators.

CSU COLLABORATORS

Breidt, F. Jay	Statistics, CSU
Clements, Will	Fish & Wildlife
Cipra, Jan E.	Soil & Crop Sciences
Cooper, David	Earth Resources
Dangelmayr, Gerhard	Math
Davis, Richard A.	Statistics
Demartini, James C.	Microbiology
De Miranda, Michael	School Of Education
Denning, A. Scott	Atmos. Sci.
Estep, Donald J.	Math
Hoeting, Jennifer A.	Statistics
Johnson, Brett	Fish & Wildlife
Kelly, Eugene F.	Soil & Crop Sciences
Loomis, John B.	Ag & Resource Econ.
Magennis, Ann	Anthropology
Mccabe, Terrence	CU Boulder
Noon, Barry	Fish & Wildlife
Omi, Philip N.	Forest Rnglnd Wtrshd Stwdshp (FRWS)
Poff, N. Leroy	Biology
Reich, Robin	FRWS
Roath, L. Roy	FRWS
Romme, William H.	Forest Sci
Rondeau, Renee	Fish & Wildlife
Thomas, James W.	Math
Urquhart, N. Scott	Statistics
Vukicevic, Tomislava	CIRA
Wallace, George N.	NRRT
Weiler, Stephan A.	Economics
Wunder, Bruce A.	Biology

INTERNATIONAL COLLABORATORS

Bagine, Richard	Kenya Wildlife Service
Banyikwa, Feetham	Univ. of Dar es Salaam
Bardgett, Richard	Univ. Lancaster, UK
Behan-Pelletier, Valerie	Agriculture Canada
Behnke, Roy	MLURI, Scotland
Borner, Markus	Frankfurt Zoological Society
Bradford, Mark	Imperial College, UK
Cleaveland, Sarah	Edinburgh Univ., UK
Dolman, Han	Netherlands
Fryxell, John	Guelph University, Canada
Georgiadis, Nick	Mpala Research Center, Kenya
Gereta, Emmanuel	Tanzania National Parks
Grootenhuis, Jan	Veterinarians sans Frontiers, Kenya
Hall, David	Kings College, UK
House, Jo	Kings College, UK
Karakulov, Amir	Livestock Research Inst., Kyrgyzstan
Kerven, Carol	MLURI, Scotland
Kidunda, Rashidi	Sokoine Univ., Tanzania
Kinyamario, Jenesio	Univ. of Nairobi
Kijazi, Alan	African Wildlife Foundation, Tanzania
Kutsch, Werner	University of Kiel
Liedloff, Adam	CSIRO, Australia
Ludwig, John	CSIRO, Australia
Malmakov, Nurlan	Kazakstan
Mwilawa, Angelo	Tanzania Ministry of Agri.
Mutero, Wycliff	Kenya Wildlife Service
Njoka, Jesse	Univ. of Nairobi
Olff, Han	Groningen Univ. Netherlands
Otter, Luanne	Univ. of the Wittwatersrand
Ottichilo, Wilber	RCMRD, Kenya
Reid, Robin	ILRI, Nairobi
Runyoro, Victor	NCAA, Tanzania
Rwambo, Paul	Kenya
Scholes, Mary	Univ. of the Wittwatersrand
Scholes, Robert	CSIR, South Africa
Sinclair, Tony	Univ. of British Columbia
Slotow, Rob	Univ. of Natal, South Africa
Thornton, Philip	ILRI, Nairobi
Toal, Mark	NERC, UK
Togtohyn, Chuluun	Mongolia
Western, David	ACC, Kenya
Worland, Roger	British Antarctic Survey
Wynn-Williams, David	British Antarctic Survey

APPENDIX VII. External Letters of Support

NICHOLAS SCHOOL OF THE ENVIRONMENT AND EARTH SCIENCES
DUKE UNIVERSITY

30 October 2003

Dr. Diana H. Wall
Professor and Director, Natural Resource Ecology Laboratory
Colorado State University
Fort Collins, CO 80523

Dear Diana:

I am pleased to write this letter of support for the Natural Resource Ecology Laboratory's proposal to become a Colorado State University "Program in Research and Scholarly Excellence." Most surely, NREL is deserving of this distinction; indeed, it is emblematic of such a title.

Mention Colorado State University to an ecologist anywhere in the world and they will immediately think NREL. For decades, NREL has been one of the world's major centers in interdisciplinary research dedicated to the understanding of the structure and function of ecosystems as well as their connections to processes that operate on a global scale. It was here that computer simulation modeling found its first practical application to ecosystem science and management. NREL was one of the first programs in the world to address in a serious way how to "scale up" from local studies to gain an understanding of regional and global processes.

The diversity of research carried out at the NREL is astounding, ranging from the energetics and biogeochemistry of grasslands to dynamics and health of forests in the Rockies to chronic wasting disease in deer. NREL's research is both local and global. The years of work in Colorado have greatly enhanced our understanding of that state's ecosystems and contributed significantly to improvements in their management. In this way, NREL has been a central contributor to Colorado State University's land grant mission. At the same time, NREL's work reaches to nearly every continent and has had a mighty impact on CSU's global reputation.

Although its core mission is research and scholarship, NREL has played a significant role in the broader life of the University. It provides teaching expertise and mentoring to a number of university programs, most especially the Colleges of Natural Resources and Agriculture. It has also made important contributions in public education through outreach programs such as the Colorado Front Range GK12 that brings research on human impacts on ecosystems along the Front Range into K-12 classrooms.

To repeat, NREL is the exemplar of a "Program in Research and Scholarly Excellence." Colorado State University is fortunate to have such a program. It will honor itself as well as the NREL with this formal designation.

Best wishes,

Norman L. Christensen, Jr.
Professor of Ecology
Emeritus Dean

...University, Box 90328, Durham, NC, 27708-0328, USA • t: 919-613-8000 • f: 919-684-8741
...env.duke.edu

ICSU
International Council for Science

9 October 2003

Professor Diana H. Wall
Natural Resource Ecology Laboratory
Colorado State University
Fort Collins
CO 80523
USA

Program in Research and Scholarly Excellence

Dear Professor Wall,

It is my understanding that NREL will apply to become a "Program in Research and Scholarly Excellence" of the Colorado State University. As someone who has worked with NREL for the past 30 years, I would like to give my strong support for this proposal.

NREL has had very high international recognition ever since the inception of the US IBP Grassland Biome Studies under the eminent leadership of the late Professor George Van Dyne. It was during this period that I first became familiar with NREL excellence in ecosystem science.

During my own research and administrative careers, I have always followed the developments at NREL with great admiration. When I was PI of a large Swedish agroecosystem programme, I hired a graduate student, Keith Paustian, from NREL to be responsible for our modelling work. Professor Paustian returned to NREL after receiving a PhD in Sweden in my programme. He is now a world scientific authority on microbial regulation of nutrient cycling. The then Director of NREL, Professor Robert Wodmansee was one of the eminent international scientists appointed to the external review board of the Swedish programme.

Many of NREL and Swedish students and faculty crossed the Atlantic on numerous occasions to strengthen collaboration in teaching and research. The leadership of NREL in informal training, supervision of students, support of Postdocs and as a dynamic organizer of national and international workshops is well known and appreciated in the international scientific community.

Later I also had the opportunity to recruit Dennis Ojima to work with me in the formative years of the International Geosphere-Biosphere Programme (IGBP) of ICSU. Professor Ojima returned to NREL and is now, among many other things, Co-Chair of the planning for a new and exciting IGBP project LAND.

In my current position, I have also had the opportunity to admire your own leadership in the International Biodiversity Year (IBOY), which is part of the ICSU DIVERSITAS programme. You were very successful in linking scientists throughout

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the world with a common vision, and the outreach activities of IBOY should be an example for many international endeavours.

These are just a few personal experiences of what NREL and its staff have contributed. The leadership that you and you predecessors have provided has put Colorado State University on the world map of ecosystem science. The breadth as well as depth of the research is astounding and you have been able to be in the forefront of the developments of international ecosystem science for decades. Your recent initiatives to address science for sustainable development must also be applauded. Only a few laboratories worldwide have had the vision to embark on this new and exciting scientific journey. That NREL provides a central part of that intellectual drive gives me great confidence in the future of this bold new ICSU initiative.

It is my sincere hope that NREL will be selected as a "Program in Research and Scholarly Excellence".

With my best personal wishes,

Yours sincerely,

Thomas Rosswall
Executive Director

MARINE BIOLOGICAL LABORATORY

7 MBL STREET • WOODS HOLE • MASSACHUSETTS • 02543-1015 • (508) 548-3705 • FAX (508) 457-1548

THE ECOSYSTEM CENTER

October 30, 2003

Chair, Selection Committee
Program in Research and Scholarly Excellence
Colorado State University
Fort Collins, CO

Dear Selection Committee:

I am writing this letter in support of the Natural Resources Ecology Laboratory's (NREL) application to become a Program in Research and Scholarly Excellence (PRSE) at Colorado State University (CSU). NREL has a long and distinguished history in the area of environmental science with an outstanding national and international reputation. For more than a quarter of a century, NREL has been doing pioneering research in both basic and applied ecology, particularly with respect to grassland ecosystems. Early in its life, NREL led the way in systems analysis applied to ecological problems. NREL scientists did groundbreaking work in ecological modeling as participants in the International Biosphere Program. From that time forward NREL researchers have shaped the way generations of quantitative ecologists have approached the mathematical modeling of whole ecosystems. The models developed at NREL, such as CENTURY, have become "industry standards" and are used by researchers and resource managers across the globe. Young scholars from developing countries have come to CSU to learn how to use these modeling tools so that they can help their nations develop sustainable regimes for environmental management.

NREL scientists have exerted leadership in the study of some of ecology's most pressing issues including biodiversity loss and climate change. Besides doing path-breaking research they hold leadership positions in international programs such as DIVERITAS and the International Geosphere Biosphere Program (IGBP).

A very objective indicator of the stature of NREL's research program is its federal funding record. In competitions where the funding rates are in the range of 5-10%, NREL is among the most successful groups in the country. In sum, NREL's scientists are among the best of their kind and the NREL deserves to be designated a PRSE at CSU.

Sincerely,

Jerry M. Melillo
Co-Director