

Report of the Review Committee

For the Natural Resource Ecology Laboratory at

Colorado State University

Introduction

A review committee appointed by the Dean of the Warner School of Natural Resources met at Colorado State University, November 19-21, 2014, to provide outside review and counsel regarding the status and opportunities for the Natural Resource Ecology Laboratory (NREL). The committee consisted of Larry Band (Director, Institute for the Environment & Professor, University of North Carolina), Molly Jahn (Professor of Agronomy, University of Wisconsin), Margaret Palmer (Director, National Socio-Environmental Synthesis Center & Professor, University of Maryland) and William H. Schlesinger (President Emeritus, the Cary Institute of Ecosystem Studies). The Committee benefited by the receipt of a rather brief overview of NREL prepared by its Director and sent to committee members prior to their visit to the CSU campus.

In a nutshell, the NREL remains one of the premier environmental research groups in the United States, focusing its attention on issues of large-scale land management and global change ecology.¹ Work of its scientists has been instrumental in informing models of the impacts of climate change on agriculture, agricultural soils and forestry. The NREL and its affiliated staff of nearly 70 scientists hold a variety of accolades from organizations and institutions around the world. In its history of 47 years, NREL scientists have published more than 4000 scientific papers, including 257 that have been cited more than 100 times by researchers worldwide.² No serious student, stakeholder or policy maker in the area of global climate change is unaware of the work performed at the Laboratory. The laboratory also embraces a major effort in environmental education and literacy, led by its Director, John Moore.

¹ Some representative peer institutions include the Department of Global Change Ecology at the Carnegie Institute at Stanford, the Desert Research Institute (DRI) at the University of Nevada, the Cary Institute of Ecosystem Studies, Millbrook, NY, and the Ecosystems Center at the Marine Biological Laboratory at Woods Hole.

² Web of Science, 25 November 2014

Historically a “soft-money” institution, NREL’s scientists are collegial and collaborative, garnering \$28.9 million in extramural support during the past three years from a variety of (largely) U.S. federal agencies. In an era of declining support for basic ecological research, NREL scientists have a proposal success rate in excess of 25% with the National Science Foundation. Although the overall funding garnered by the Laboratory has trended downward during the past five years, funding rates today are roughly similar to those 10-12 years ago. Nevertheless, the national arena for extramural funding is not likely to grow, and may significantly decline, so NREL must look to new funding opportunities to maintain existing strengths and grow its portfolio.

The Committee was pleased to hear that the creation of the Department of Ecosystem Science and Sustainability (ESS), gave a number of NREL scientists partial hard-money appointments as faculty in the School of Natural Resources. Several others have joint (or primary) hard-money appointments with other Colleges, including Natural Sciences (Galvin and Wall) and Agriculture (Cotrufo and Paustian). Scientists affiliated with the USDA UV-B Monitoring and Research Center (Wei Gao), the North Central Climate Center (Jeff Morissette), the USGS Wesley Powell Center (Jill Barron), and with other groups on the CSU campus are important to the success of the overall NREL program.

Faculty in NREL train graduate students through participation in the existing Graduate Degree Program in Ecology (GDPE) and will also supervise students in the new graduate program within ESS. The GDPE is vibrant, and students seem excited and happy to be in the NREL family at CSU. Postdoctoral associates in NREL and most graduate students are funded via the extramural research grants of the faculty.

Like all academic departments and institutes, the NREL will face challenges as its long-standing faculty begins to retire, new positions are defined, and faculty recruited. Who fills those positions will determine the success of NREL in approaching new research initiatives that may fall beyond the traditional purview and funding sources that have been successful for the Laboratory in the past. The appropriate balance of faculty with full or partial hard-money appointments in the Department of ESS and other departments, versus soft-money positions within NREL, is a point of potential conflict, but also opportunity. The expectations for teaching, administration and student advising by hard-money faculty will need to be better

defined and not significantly impact their ability to obtain research funding. Additionally, the role of the University initiative known as the School of Global Environmental Sustainability (SoGES) on the CSU campus remains somewhat unclear and worrisome to NREL scientists. The committee encourages CSU leadership to clarify the relative roles and responsibilities of the array of administrative units now operating in the broad research domains of environmental science

NREL on the Colorado State Campus

Colorado State University has a set of strong units focused on the environment, with multiple colleges, departments and faculty contributing significant research, education, and outreach in areas aligned with different disciplinary realms. The NREL is widely viewed, both on and off campus, as a premier research group in ecosystem science and a major university asset. Within the College of Natural Resources, the mix of departments and other institutes provides complementary strengths and missions to the NREL focus, which could be further leveraged.

The long-standing model of soft-money support for NREL had been largely successful in forging a very integrated, collegial environment in which researchers closely interact on the development of grant proposals and synthesis of new research that has been both well-funded and highly influential. Recent trends in funding levels and increased competition for grants and contracts from traditional funding agencies (NSF, NASA, USDA, others), and shifts in research sources and priorities have created a somewhat stressful condition for this model of operation and the culture that developed at NREL.

With the recent creation and expansion of joint academic appointments within the Natural Resources and other colleges, and the creation of a new department, NREL personnel are significantly expanding their role in education across the CSU campus, with direct management and teaching of undergraduate degree programs, development of new graduate programs, and greater integration into the university academic mission. While a few NREL researchers have primary appointments in other colleges (Natural Sciences, Agriculture, and Liberal Arts), the majority of the academic appointments are within the new Department of Ecosystem Science and

Sustainability. There is apparent interest from the various Colleges on the CSU campus to increase the number of joint appointments, which would leverage the strengths of NREL to recruit and retain talented faculty. The addition of personnel with mixed research, teaching and administrative responsibilities is beneficial, but it also has the potential to alter the tightly integrated research culture as greater responsibilities develop around other professional activities. Success will require a greater level of academic “juggling” and interaction with the wider campus community than has traditionally been the case. It was not clear from the material provided to the review team what level of academic cross-appointment or teaching loads were assigned to NREL personnel, or what other academic administrative responsibilities are distributed. The move of faculty from the former Forest, Range and Watershed Science Department with different science backgrounds brings the potential to expand and leverage existing strengths, while also adding needs for different research facilities.

While the NREL research presentations showed good evidence of interaction between faculty and students in watershed science and ecology, it was unclear what integration of the graduate and undergraduate programs and facilities has been achieved. The new academic programs administered by NREL faculty have some degree of overlap with other existing and new programs on campus. The Graduate Degree Program in Ecology (GDPE) is highly regarded nationally, and has had strong support and interaction with NREL personnel. Discussion with faculty indicated a strong interest in developing a complementary approach to the GDPE with the new graduate program of ESS, but this will need to evolve and should not be expected to be mutually exclusive in focus or graduate faculty. Some degree of umbrella coordination should be developed so that interested students can look at both programs (and other related programs on campus) to choose which is most appropriate. Joint activities, seminars, and classes would be ideal. A similar overlap exists between the several water-focused degrees and units on campus, with at least three separate degree programs (ESS, Geoscience, and Civil Engineering), and three centers (NREL, the Colorado Water Institute, the Confucius Center) involved, which should develop better cross-campus coordination towards the goal of becoming a leading, international program in this area.

The School of Global Environmental Sustainability (SoGES) provides additional leverage and overlap for NREL and the Department of ESS. The SoGES mission appears to be more interdisciplinary, educational, and campus-wide, providing a forum and infrastructure for faculty from all schools to interact on sustainability issues, while offering an interdisciplinary Sustainability minor. University funding for interdisciplinary activities, including seminars and pilot projects, could leverage and help expand NREL's interaction and activities with the wider set of academic disciplines on campus. Coordination and negotiation between the programs will also be required, but could elucidate important complements of shared goals and outcomes. Housing the new Future Earth initiative in SoGES may provide increased resources to further connect and leverage NREL personnel with social scientists, engineers and other faculty across campus.

Space and facilities are a perennial issue on most university campuses, and often accompany administrative shifts similar to those NREL has experienced. While the review team did not have the opportunity to tour the full NREL space, the addition of new faculty, expanded graduate student enrollment, and the need for resources for a rapidly growing undergraduate program requires a careful assessment, inventory, and (re)allocation of current space in order ensure its most efficient use and to make the case for increased needs. Our understanding is that a new building is envisioned as part of the current campus development campaign, but this may take several years to materialize. New resources for the expanded educational mission should be seen as complementary to the NREL research mission by developing an expanded undergraduate research component, which should materially benefit and strengthen research projects and proposal competitiveness.

NREL currently operates a set of analytical facilities as the EcoCore, which is used by NREL scientists and others across and outside of CSU. With a few exceptions, the equipment is modern and well-maintained. The mechanism for periodic upgrades and replacements was unclear, and appears to be opportunistic as new faculties join with start-ups or new grants. NREL should prepare for major expenditures for new or replacement equipment within the next decade. Space within this facility seems adequate, although it might be reconfigured for maximum use-efficiency, and as a core facility for CSU it was not clear what central funding or resources are

available. It is also likely that the EcoCore facilities would need to be reconfigured, expanded or replicated for some undergraduate use, with support from the College and the University, for the success of regular classes as well as undergraduate research. While the shared CORE facility is excellent for analytical work, daily interactions between faculty and their postdocs and graduate students may require additional space.

The analytical facilities are supplemented by personnel who specialize in IT and data management support for the scientists at NREL. The Committee found that the IT capabilities and services are appropriate for current research programs and admirably responsive to the rapidly changing field of computational science, genomics, and the management of large datasets.

Challenges and Opportunities for NREL to move forward

The NREL has been remarkably successful for nearly 50 years by focusing on areas of funding that have served individual research programs and the community well. There was general agreement among both the review team and many of the NREL scientists and administrators that US federal funding for scientific research is likely, at best, to remain stable and perhaps even trend downward, presenting both short and longer term challenges to the NREL model. With this expectation, two strategies are obvious. The first focuses on ensuring that NREL is positioned to successfully compete for the available, though likely diminished, funding from Federal agencies and programs. The second focuses on broadening the portfolio of funding sources from grants and from entrepreneurial and unconventional modes.

With respect to the first strategy, a clear inventory of the assets of NREL including its core facilities, as well as improved materials to describe the current accomplishments of NREL scientists would be most helpful. One clear message we received is that the uncertainty of soft money creates instability for the entire community, so elucidating specific approaches to ensure core funding, from grants, instruction or an endowment, should be a priority.

NREL has focused with great fidelity on its original strengths in garnering Federal research grants, but the opportunity exists now for a broader integration of funding sources. This

integration may require new academic and scholarly relationships and new and/or strengthened relationships with communities of practitioners and stakeholders who manage landscapes.

NREL Education and Outreach

The committee was not provided with information on the courses, course loads or faculty who participate in the existing or new teaching programs at CSU, other than what could be gleaned from individual CVs. It is clear that with the creation of the Department of ESS, the role of NREL scientists in education is growing. The committee was also not provided with any evidence that there is a coordinated outreach or extension program within NREL. NREL is in a perfect position to expand its education efforts in ways that should bring both short-term rewards and expand outreach/extension that bring rewards over longer periods of time.

Two factors make this an opportune time for NREL to expand its education programs. First, the funding climate is shifting dramatically in the U.S. Far fewer funds from the federal government for NREL research are currently available and that is not expected to change in the foreseeable future. At the same time, research funding is shifting toward a far more use-inspired model. The demand for federal research with direct societal benefits is becoming the norm and stakeholders are increasingly expected to play a role in the research process. Foundations that have funded academic research are shifting to models in which they exert a great deal of control over the research they fund so that it serves their own goals which may advocate a specific outcome.

Second, the work force is demanding that employees and new hires have technical expertise that is often specialized and fills unique needs, particularly in the computational and cyber arena. It is increasingly difficult for “well-rounded” students with a B.S. in Biology or Environmental Science to get a position that is at a level commensurate with their degree. What gives applicants an advantage are computational skills associated with modeling and programming languages, statistics associated with forecasting, and skills in risk assessment or laboratory analysis.

With its focus on ecosystem science, NREL is the perfect candidate to develop a host of opportunities for both traditional and nontraditional students that will simultaneously meet

student needs and bring resources to the Laboratory. These opportunities could take the form of short-courses (e.g., such as the Bayesian course that Tom Hobbs already teaches), certificate programs, analytical training, and professional masters programs. Examples of successful programs include: the University of Michigan’s professional M.S. program in Conservation Biology that is a major form of support for the School of Natural Resources. Similarly, programs and short courses in Restoration Ecology at Utah State and Berkeley attract a large number of professionals from consulting firms and government. These courses typically provide support for faculty and graduate students and in some institutions can be used to justify the purchase of field equipment or lab instrumentation. Special opportunities may exist to involve students from China and collaborations with various institutions in China that seek special skills in environmental science and land management.

Where appropriate in light of the need to expand educational offerings, NREL researchers should consider courses in their curriculum or expertise that have special appeal to visiting students or to adult students who are practitioners in related fields and who seek further professional development. NREL should consider what courses or special programs will showcase the unique strengths and expertise within NREL. Most campuses have a unit that will help with the development of a budget plan and also with marketing of courses for nontraditional students. These units are often called offices of “Extended Studies” or “Professional Development”, etc.

Outreach/Extension/Stakeholder Engagement

NREL has a tradition of integrated basic and applied research. Given the shifts in the research landscape toward actionable science that is inspired by the needs of potential “knowledge users,” NREL is well positioned to be a leader in the future. However, the committee’s sense is that while the work of many NREL scientists is inspired by societal problems, there is a great deal of room to expand its transdisciplinary approach—that is, an approach that brings stakeholders directly *into* the research process. Transdisciplinary research begins with stakeholders who help develop research questions and who identify what forms of output are most useable. Transdisciplinary research returns repeatedly to the stakeholders to ensure researchers are producing useful information.

Developing a closer relationship between researchers and stakeholders is the new form of outreach. It avoids the linear delivery model of education and even goes beyond the traditional extension approach so common in land grant universities historically. It does not necessarily eliminate the need for science translation, but it does change the nature of the relationship between researcher and user. The process is somewhat more time consuming than the “research delivery model,” but over time, as trust is established and stakeholder needs are met, growth in research opportunities should arise. The committee was not in a position to identify the most appropriate stakeholder groups – industries, land managers, agriculture, etc. – but this is something that NREL should consider very strategically.

The committee emphasizes that use of this model does not mean that NREL ceases doing fundamental research. Instead, a portfolio of projects that spans highly applied to large question focus should be the goal, with basic science embedded throughout the work. Often the stakeholder needs themselves involve the traditional, fundamental questions addressed at NREL, but when they do not, clever sampling designs and multi-project leveraging can lead to great basic science.

Private Funding and Fund-Raising.

The Committee recommends that CSU pursue private philanthropic sources of funding for NREL, focusing on alumni who are involved in the management of large land holdings or extractive industries. Such a development effort might produce endowment for certain operations of NREL to a naming opportunity for the entire laboratory. We recognize that such fund-raising is not easy, but the rewards are potentially great and transformative. For instance, the Cary Institute of Ecosystem Studies in Millbrook, NY, currently operates on an annual budget of approximately \$10 million, with 50% provided by earnings on endowment. NREL's history of distinctive contributions through excellence in research may be appealing to foundations and larger environmental non-profits who frequently control very powerful fund-raising networks. As faculty retire and the Laboratory sets its strategies for the next decade, a balance between opportunistic and targeted efforts to secure an endowment would be wise to consider. It may not be effective to expect that the university's regular fund-raising personnel,

already stretched thin to cover traditional obligations, will be able to handle this increased demand for attention.

Summary Points for Action

1. NREL must consider new funding options and initiatives to expand its resources as a “soft-money” operation in the CSU campus.
2. CSU has provided a modest level of stability to the group of scientists at NREL, as a result of partial hard-money appointments in the Department of ESS. How much teaching, advising and administration will accompany these appointments will need definition.
3. NREL faces considerable opportunities as its long-standing members retire and new scientists are invited to join the group.
4. CSU should engage in continuous appraisal and adjustment of the domain and expectations of various units involved in studies of the environment and training of graduate students on its campus.
5. NREL faces many opportunities to expand its education offerings to provide skills that are in demand by employers and skills that are sought by non-traditional and international students.