Ecological careers at Federally Funded Research and Development Centers


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Scientific breakthroughs at Federally Funded Research and Development Centers (FFRDCs) can lead to changes in policy and affect funding priorities for ecological research. For example, while the scientific hypothesis underlying the relationship between land-use change (LUC) and climate change had been long established (Revelle and Suess 1957), for decades there was great uncertainty about how current deforestation influenced atmospheric CO_2 and thus climate change. It took a dedicated team of ecologists, historians, foresters, geographers, and economists to document how current effects of LUC alter atmospheric CO_2 concentration by about 10% rather than the high estimate of 50% (Post *et al*. 1990; Dale *et al*. 1991). This team, led by an FFRDC, showed that since the early 1900s fossil-fuel combustion has been the major contributor to the annual flux of carbon to the atmosphere. The good news is that this work influenced policy makers to focus on the burning of fossil fuels as the main contributor to climate change. The bad news is that it also decreased funding for research on LUC since its effect on climate change was found to be relatively small.

Testing such complex scientific hypotheses is a key emphasis of FFRDCs. These institutions provide an engaging career opportunity for scientists interested in a career spanning both basic and applied ecology and that involves investigating subject matter with environmental policy implications. If you want to apply your expertise in a group setting to address the most challenging scientific issues of the day, FFRDCs are the place for you.

FFRDC research is often interdisciplinary and involves large teams, going back to its roots in the Manhattan Project, which engaged more than 130,000 people in atomic research during World War II and laid the groundwork for having many scientists tackle a single problem. In 1960, two FFRDCs, Oak Ridge National Laboratory (ORNL) and Savannah River National Laboratory, initiated research in radioecology, as lands contaminated with radioactive waste provided an "opportunity" for tracing nutrients through ecosystems. Subsequently, systems ecologists at these and other FFRDCs and universities established the foundations for ecological modeling and ecosystem studies under the International Biological Program (IBP), which ran from 1964 to 1974. Today, FFRDC researchers explore safe and environmentally appropriate energy options and address other national challenges.

Throughout the US, ten FFRDCs currently perform ecological research under contracts with the US Department of Energy (DOE) and the National Science Foundation (NSF) in diverse topics, including sustainable agriculture, renewable energy, climate change (Figure 1), genomic ecology, and environmental and societal impacts of human activities (WebPanel 1). Many of the computations for the Intergovernmental Panel on Climate Change (IPCC) were performed on ultra-fast FFRDC supercomputers. High-performance computing is an example of user facilities that form the hallmark of FFRDCs (https://science.energy.gov/user-facilities).

Career opportunities at FFRDCs include positions for analysts (who work in field or laboratory settings), computer modelers, theorists, and specialists in geographic information systems as well as communications. The science is focused on testing hypotheses and never advocates a particular outcome. Rather, information is produced in an unbiased fashion.

While FFRDCs hire scientists who typically have a masters or doctorate degree, these institutions also employ lawyers, business managers, and human resource specialists who must understand how science is conducted. FFRDCs are often on the lookout for new staff, postdocs, post-masters fellows, and graduate students. At each FFRDC, announcements for new positions are posted on institutional websites, and scientific staff and recruiters actively search for prospective employees by attending presentations at scientific meetings. It is useful to let a current staff member know if you are interested in a position at their FFRDC.

The skills needed by a particular FFRDC vary, but commonalities are discussed below. Some of these abilities can be acquired through on-the-job training or experience.

In-depth knowledge in a scientific discipline: Productive scientists at FFRDCs have specialties in a discipline such as ecology, zoology, botany, environmental engineering, economics, sociology, plant physiology, genetics, soil science, geography, risk assessment, mathematics, or statistics. Each scientist is expected to keep up with advances in their respective fields by reading scholarly literature, participating in professional development activities, and engaging with other experts.

Interest in working as part of an interdisciplinary team: Interdisciplinary knowledge and the interest and ability to work across disciplines are essential. So, researchers must carefully define terms, for a word can have a different meaning or implication in another discipline. Listening carefully to each team member is essential. Many ideas are developed via group meetings, and most publications have multiple authors.

Willingness to challenge ideas: Because FFRDC scientists are involved in cutting-edge research, they must be innovative and


ORNL

Figure 1. The Spruce and Peatland Responses Under Climatic and Environmental Change (SPRUCE) experiment is measuring changes in peatland biogeochemical cycles over 10 years in Minnesota. It used an FFRDC-designed facility for exposing forest plots to elevated temperatures and CO_2 levels and provides a means to examine belowground activity where most of the ecosystem's carbon is stored.

think creatively. While studying new concepts to identify conundrums and suggest paths forward, FFRDCs scientists often question their own ideas as well as those of others.

Flexibility: FFRDC scientists also creatively envision approaches and identify tools to resolve specific challenges. The need for flexibility can come into play when support for a particular topic declines as problems are solved or as the political climate changes.

Persistence: The ability to persevere in the face of real and perceived obstacles is important. Such determination supports a focus on the end goal rather than on distractions (such as paperwork or meetings). For this reason, it is useful for team members to clearly articulate the group's overall purpose, methods to achieve it, and the role of each participant.

Ability to communicate effectively: Scientists at FFRDCs organize, analyze, and interpret scientific data and effectively communicate their questions, insights, and knowledge via technical writing, presentations, and one-on-one discussions. While publication of results in leading scientific journals is expected, direct communication of insights to federal sponsors, policy makers, nongovernmental organizations (NGOs), and industry often facilitates science-based decisions.

FFRDCs hire scientists and engineers with a range of backgrounds and skills, depending on the problem being addressed. That expertise often includes quantitative skills in modeling or analysis. FFRDCs recognize that a researcher's current skills may be appropriate for addressing different problems. Mentoring is an important part of the scientific culture, and there are opportunities both to be guided by and to provide support to those with different experience levels.

FFRDC scientists are not federal workers; rather, they are contractors employed by private companies. While each contract is unique, the associated benefit packages are usually quite favorable (including pension plans and health insurance). Because they depend on funding from projects rather than from federal budget allocations to agencies, FFRDC scientists often develop proposals and are always thinking about new ideas. A program officer at NSF once said that ORNL should be "in front of the cutting edge of science", which is a precarious position in terms of securing financial support but is nonetheless exciting. For this reason, the lack (or perceived lack) of continuous funding can cause concerns about long-term job security. FFRDCs do not have tenured positions, and research directions can change in response to fluctuations in government priorities. At times, therefore, staff turnover can be high in certain fields. However, when scientists' skills are applicable to a variety of problems, under changing conditions those persons often alter their research focus.

The work by scientists at FFRDCs is self-directed by the proposals they develop. These proposals can be submitted to any agency, NGO, or private-sector entity but must not compete with universities or industry. Most of the work at any particular FFRDC is funded by its sponsoring agency and, in the case of environmental work, that is either DOE or NSF. Importantly, DOE policy ensures that contractors are free to discuss their work (https://energy.gov/downloads/department-energy-scientific-integrity-policy).

There are several ways to learn about FFRDCs. You can gather information from individuals, publications, or the web about the interdisciplinary science conducted at these institutions. Furthermore, FFRDC scientists often participate in scientific conferences (including the ESA's annual meetings), and most are available for guest lectures, visits, webinars, or conference calls. The staff and students at FFRDCs are highly diverse and come from many nations and institutions. Most positions in the environmental sciences at FFRDCs do not require US citizenship. Finally, FFRDCs offer internships to students (high school, college, graduate school), teachers, and faculty (many are available through the Oak Ridge Institute for Science and Engineering: https://orise.orau.gov), as well as other opportunities to spend time at a particular institution.

Working at an FFRDC is rewarding because you can develop new theory and apply your research to today's pressing environmental problems while being part of a collaborative team and using the most advanced equipment.

Supporting Information

Additional, web-only material may be found in the online version of this article at http://onlinelibrary.wiley.com/doi/10.1002/fee.1978/suppinfo

Author biography

Virginia H Dale is a Corporate Fellow Emeritus at the Oak Ridge National Laboratory, where she worked for 34 years, and recently transitioned to the University of Tennessee. She has served on national scientific advisory boards for five US federal agencies and several committees of the National Academies of Sciences, Engineering, and Medicine.