

CAREERS

COLUMN Expediting visa approval helps to lure research talent **p.303**

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D. INOUE



The Rocky Mountain Biological Laboratory field station outside Crested Butte, Colorado, offers high-tech facilities for fieldwork.

FIELDWORK

The great outdoors

Field stations offer sophisticated facilities and opportunities for large-scale research.

BY ROBERTA KWOK

Noah Whiteman's 2011 field season was tough. He and his team spent two summer months in the Rocky Mountains studying whether bacterial infections made plants more vulnerable to herbivores. They wanted to isolate bacteria from collected leaves to infect plants in the field, but the station at which they were working, the non-profit Rocky Mountain Biological Laboratory (RMBL) near Crested Butte, Colorado, did not have the equipment to support sterile laboratory work.

So two to three times every week, the team drove an hour each way to Western State Colorado University in Gunnison to autoclave nutrient media and pour it into Petri dishes

ready for growing bacteria. They were grateful for the facilities, but the process "was really cumbersome", says Whiteman, an ecological geneticist at the University of Arizona in Tucson. "We were exhausted."

But by Whiteman's 2012 field season, the RMBL had built a new research centre — with Bunsen burners, microfiltered water and fume cupboards for chemical work — mainly with funding from the 2009 stimulus package from the US federal government. The facilities got even better in 2013, when funding from the US National Science Foundation (NSF) and private donors allowed the station to add an autoclave, a shaking incubator, a polymerase-chain-reaction machine and a -80°C freezer. The team could now store more plant and bacteria samples and process them much more quickly.

Many field stations used to offer biologists little more than access to the land, basic equipment such as microscopes and a place to sleep. But over the past decade or so, stations around the world have begun adding more sophisticated features: molecular-biology equipment, Wi-Fi, Global Positioning System (GPS) devices and features ranging from towers that allow researchers to monitor the forest canopy to facilities for conducting large-scale lake experiments. The upgrades, often funded by government grants, are driven partly by the falling cost of technology. Meanwhile, there is growing scientific interest in complex, large-scale research questions — including projects on the effects of climate change, invasive species and pathogens across entire regions. To support this work, programmes such as the ►

► NSF-funded US National Ecological Observatory Network (NEON), based in Boulder, Colorado, are collecting standardized ecological and atmospheric data across whole countries — a far cry from the simple collection of flora and fauna that once characterized field-station research. “Back in the day, you were just grabbing creatures,” says Sarah Oktay, director of the Nantucket Field Station operated by the University of Massachusetts Boston. Now, she says, scientists are more interested in big questions relevant to entire regions.

HIGH-TECH FACILITIES

Upgraded Internet access at some stations allows researchers to upload data automatically from field sensors to university servers or data repositories. In 2006, with funding from the NSF, the Nantucket Field Station installed Wi-Fi over about 80% of its 43-hectare site, giving scientists online access to sensors to track species of interest (one team installed cameras to record videos of fiddler crabs) or monitor temperature, light or soil moisture. That speeds up access to data and makes it easier to find out whether a sensor has broken down. Otherwise Oktay might “have to put on a pair of waders and drive about 20 miles” to discover a broken sensor, she says.

Improved mapping technology allows scientists to collect precise location data. In 2004, the RMBL began offering handheld GPS units to visiting researchers. At the time, the units were able to pinpoint locations to within 100 centimetres; 2 years ago, with access to more satellite data, they could reach 20–40 centimetres. The station maintains a database of spatial information such as elevation data and locations of roads and species, so that researchers can look for correlations between their observations and other factors, for example between animals’ adrenaline levels and the creatures’ distance from recreational trails. And scientists conducting long-term studies can be confident that they are returning

to the same spots year after year, instead of relying on physical markers that might be moved or buried by wildlife.

Some field stations have installed especially sophisticated experimental facilities. In 2008, with NSF funding, the La Selva Biological Station in northern Costa Rica, managed by the non-profit Organization for Tropical Studies in Durham, North Carolina, completed 3 towers between 33 and 41 metres high that were equipped with electricity and Wi-Fi, allowing easy access to the forest canopy. The towers were constructed to make the station more attractive to researchers and educators, says station director Carlos de la Rosa. A robot shuttles between towers on cables and collects data on surface reflection, solar radiation and sound; weather stations gather meteorological data at various heights. Researchers can study differences between ecosystems on the ground and those high above the forest floor, such as variations in the types of beetle present. One team, says de la Rosa, is considering recording butterflies with cameras at different levels, then streaming the footage to the Internet. The researchers could then recruit members of the public to watch the videos and help to identify species, saving researchers many hours of viewing time.

WATER WORK

Studies of aquatic ecosystems are also benefiting from better equipment. Last year, the Leibniz Institute of Freshwater Ecology and Inland Fisheries in Neuglobsow, Germany, set up its LakeLab facility to improve studies on the effects of climate change. Funded mainly by a grant from the Federal Ministry of Education and Research, the system consists of 24 cylindrical enclosures in Lake Stechlin, inside which scientists can simulate changes in the depth of the upper level of warm water, and measure the effects on flora and fauna. Researchers from Germany and Hungary are studying how these changes affect ciliates and algae, for example.



Jörg Sareyka (left) and Mark Gessner collect zooplankton samples at LakeLab, Germany.

The enclosures are large — about 20 metres deep and 9 metres wide — reducing the influence of the walls and allowing experiments to better mimic natural conditions, says Mark Gessner, director of LakeLab.

The advantages offered by modern field stations go beyond technology: researchers stand to gain from many years of collective wisdom. Ecological studies that began in the 1960s and 1970s have laid the groundwork for a new generation of researchers, says Ian Billick, director of the RMBL. Today, field stations provide accumulated intellectual capital: decades of original data sets, archived research plans, specimen collections and oral history that can prove invaluable to young investigators. A researcher who wants to know the best place to find a particular flower species can easily get tips from a field-station staff member or a colleague who has worked at the site, instead of sifting through published papers. “That background information is critical for allowing new scientists to get projects up and running quickly,” says Billick (see ‘Planning is the key to success’).

GOING BIG

Field-station directors often coordinate with each other and share data, allowing scientists to conduct large-scale studies. Over the past 10–20 years, the non-profit Organization of Biological Field Stations (OBFS) in Woodside, California, has worked for increased communication, says Oktay, who is secretary of the organization. Directors are also keen to support individual researchers. For example, if a scientist approaches the OBFS with an interest in studying a moth parasite in New England, the organization will e-mail all field-station

INTO THE WILD

Planning is the key to success

The basics of planning a successful visit to a field station have not changed. Be sure to book well in advance: some stations can fill up a year ahead. Consider whether the weather will be conducive to the work. “I’ve had people come and look for clams, and I’m like, well, they’re going to be under a foot of ice,” says Sarah Oktay, director of the Nantucket Field Station operated by the University of Massachusetts Boston.

Let the director know what equipment is needed and bring back-up electronics. If the station is not near civilization, don’t count on being able to buy extra batteries. And avoid

planning a packed schedule; researchers often underestimate how long fieldwork will take, and have to leave without enough data.

Once at the site, be open to opportunities and conversation, says Ian Billick, director of the Rocky Mountain Biological Laboratory near Crested Butte, Colorado. Visiting another scientist’s field site can foster rich discussions about the complexities of the surrounding environment and lead to new research directions — an experience sometimes lacking in the laboratory, where the focus tends to be limited to a few processes of interest. **R.K.**

directors in the region to find out who has collected that parasite or moth, helping the researcher to decide where to visit.

Many stations are putting their data online, making it easier for scientists to spot trends. Black Rock Forest, a field station in Cornwall, New York, already has weather and other environmental sensor data posted on a project website and plans to add hydrology and tree-growth data, as well as all of its research publications, by next year, says Bill Schuster, the station's executive director.

Federally funded programmes are gathering data on larger scales, and making them accessible to all researchers. NEON aims to collect ecological observations at 106 sites across the United States for 30 years. It has installed basic infrastructure such as sensor towers and instrument huts at 24 sites, and hopes to complete all sites by 2017, at a cost of \$434 million. Sensors will monitor features such as atmospheric conditions and soil properties at terrestrial sites, and pH, oxygen and nutrient levels in streams; field crews will study organisms and fly instrumented planes to take high-resolution aerial images and survey vegetation. In Australia, the Terrestrial Ecosystem Research Network (TERN) based in St Lucia performs a similar function, gathering data on greenhouse-gas exchange, soil characteristics, bioacoustics and weather at ten sites across the country.

NEON and TERN each collect their data in a standardized way so that researchers can make comparisons on regional or continental scales. Without that consistency, "you literally cannot say what is happening across the country", says Suzanne Long, the executive knowledge broker at TERN, who works to increase the network's impact on environmental policy and practice in Australia.

The data could complement work at specific field sites, suggests Dave Tazik, director of biology at NEON; the observatory's sites could serve as control plots while researchers experimentally manipulate other plots. "We think of it as providing a backbone of data," he says. Scientists can also apply to add their own sensors to NEON towers. Researchers could develop a hypothesis on the basis of their field-station work — perhaps investigating how plants respond to climate change — and then analyse the freely available NEON data to explore whether trends hold true on a broad scale.

Now more than ever, field stations are helping scientists to tackle big questions about pressing environmental issues, such as the effect of climate change on ecosystems. "As these systems fall apart, it's actually a very good time to study them," says Billick. ■

Roberta Kwok is a freelance science writer in Seattle, Washington.

COLUMN

Fast-tracked talent

Expediting visa approval helps countries to attract the best researchers, says **Conor O'Carroll**.

Encouraging and facilitating mobility among scientists helps both the researcher and the country thirsty for talent. Indeed, the success of the €70.2-billion (US\$95-billion) Horizon 2020 European Union (EU) research programme, set to be launched on 11 December, hinges on bringing researchers to Europe from around the globe. And yet obtaining a visa, the key to being mobile, can be a major challenge. Ireland's experience with smoothing the visa process shows one way to make the system more efficient while maintaining border security.

The EU has 28 member states, and negotiating their immigration procedures can be difficult. Eliminating differences has been a core part of European Research Area policy, and in 2005 Europe-wide legislation was introduced to ensure fast-track immigration for international researchers through the 'scientific visa'. All EU countries except Ireland, the United Kingdom and Denmark were obliged to implement this fast-track visa, but the system has been put in place with varying levels of enthusiasm and effectiveness. Ireland recognized the potentially positive impact of the scientific visa and voluntarily introduced it in 2007 to attract more researchers.

Ireland's largely successful system can serve as a model for other nations. Although Ireland aspires to be a research hub, its economy remains fragile, and science funding is tight. Ireland cannot afford to stymie the movement of talent with cumbersome visa protocols.

We use a secure online verification system that links immigration services with embassies around the world, and we have a simple application procedure to reduce bureaucracy. The online system means that after applicants obtain research jobs in Ireland, they can get visas for themselves and their families within days, rather than the previous six to eight weeks for the scientists and up to a year for their families. Scientists used to have to pay €1,000 (US\$1,300) per year for a work permit; it is now free. Ireland implements the visa through its EURAXESS office — one of 200 offices across Europe providing advice and support for mobile scientists — based in Dublin, at the Irish Universities Association (of which I am the research director).

Over the past 6 years, 1,750 researchers from 80 countries have come to Ireland using the fast-track scientific visa. Half of them came



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from China, the United States and India. How do we know that the changes have made a real difference? In March, EURAXESS Ireland carried out a survey of more than 300 researchers with scientific visas, the first such survey by any European country participating in the scheme. Of those surveyed, 84% were still working in Ireland; 27% had found employment in the areas of information and communications technology, and 26% in computer and life sciences.

Fifty-three per cent of the respondents said that the fast-track visa was very important when deciding to proceed with a job in Ireland. The survey also revealed that 23% of researchers would definitely not have come to Ireland if the fast-track visa scheme had not been in place.

Policymakers and those keen on building a nation's scientific reputation often assume that facilities and staff are the crucial factors for drawing in researchers. However, our survey shows clearly that the immigration process is key to decision-making. The story is likely to be the same for other countries that are working to increase their scientific excellence by attracting researchers.

Competing for international scientific talent is a challenge. Nations such as Ireland that have invested heavily in science only in the past decade have to compete against international leaders including the United States and the United Kingdom. Providing an easily accessible, fast-track visa can make a real difference. ■

Conor O'Carroll is research director at the Irish Universities Association in Dublin and chair of the European Steering Group on Human Resources and Mobility.