THIS WEEK

EDITORIALS

Don’t hide the decline

US scientists should not be placated by the ‘flat budget’ myth. Funds are decreasing, and the situation will get worse.

For US researchers, the annual unveiling of the presidential budget request can be a time of both hope and trepidation. But after last year’s fiscal battles with Congress, complete with an embarrassing government shutdown and painful across-the-board spending cuts, it was always clear that this year there would be little to celebrate.

In that atmosphere, the unveiling on 4 March of President Barack Obama’s US$3.9-trillion budgetary vision for fiscal year 2015 brought both disappointment and a sigh of relief. In one sense, the proposal was optimistic: it exceeded congressional spending limits by $56 billion, and there were few deep cuts for science. But it leaves the budgets of major scientific funders, such as the US National Institutes of Health (NIH), the National Science Foundation (NSF) and the research efforts at the Department of Energy, essentially flat (see page 147).

Amid a sluggish economy and zealous calls to tighten federal purse strings, the prevailing wisdom is often to be grateful for a flat budget. Things could be worse. But those projects that stand to be gutted — such as the Stratospheric Observatory for Infrared Astronomy (SOFIA), an airborne observatory funded largely by NASA, which would have its budget slashed from $84 million to $12 million — stand as painful reminders that a flat budget is not something to celebrate. The proposed $200-million boost to bring the NIH’s budget to $30.2 billion is paltry, but even worse is the $1.3-billion cut that could be in store for the Department of Health and Human Services, the NIH’s parent agency.

What is more, inflation does not stand still for flat budgets. Overall spending on research and development would increase by 1.2% in 2015 if Obama has his way. But the rate of inflation that year is expected to be 1.7%. The outlook is worse for biomedical research — here, inflation is projected to rise by 2.2% in 2015, according to the Department of Health and Human Services’ Biomedical Research and Development Price Index. The 0.7% budgetary bump that Obama has requested will not keep pace.

Indeed, ‘flat’ budgets such as those proposed last week have steadily eroded the NIH’s coffers over the past decade. Controlling for inflation, the NIH’s budget shrank by 10% between 2004 and 2014, according to the American Association for the Advancement of Science in Washington DC. The real decline is even steeper when the rate of biomedical inflation is taken into account.

A similar trend is emerging for research and development overall: federal spending on research and development in 2014 is 15.8% lower than in 2010 when inflation is considered.

Greener pastures are nowhere in sight. The president’s request was sent to Congress, which will produce a plan of its own. Included in Obama’s request is a proposed $56-billion Opportunity, Growth, and Security Initiative that would add $5.3 billion to the nation’s research and development coffers. But there is little reason to hope that the initiative will make it through a US Congress determined to rein in spending, opposed to raising taxes and not generally known for a willingness to compromise. These are, after all, the same legislators who in October shut down the government for 16 days and allowed across-the-board spending cuts of 5% last year. Science suffered as a result: the NSF awarded 690 fewer grants in 2013 than the previous year, according to figures released last week by the Government Accountability Office. The NIH cut its grants by 750. The White House’s budget proposal makes it clear: there will be no compensation for these lost opportunities.

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Meanwhile, the economic strain on the country is immense. Mandatory spending obligations — on retirement and healthcare programmes, for example — are soaring, squeezing discretionary spending on other worthy areas, including research. As a result, discretionary programmes are battling over slices of a rapidly shrinking pie: in 2010, discretionary funds were 39% of the budget; in 2015, they will be 30%.

This means that the fight will only be more intense in years to come. Rather than a relief, apparently flat budgets are a sure sign that competition for funds will grow still further. And that things will get worse before they get better. ■

An elegant chaos

Universal theories are few and far between in ecology, but that is what makes it fascinating.

To some scientists in other fields, ecology must seem relatively straightforward. Many of the organisms live at a very human scale and are easy to access, especially in community ecology. Ecologists do not need special equipment to see and count elk. There are no electron microscopes, space telescopes or drilling rigs that can go wrong. Easy.

And yet, ecologists know that their subject can prove as troublesome as any other. Ecology would be easy, were it not for all the ecosystems — vastly complex and variable as they are. Even the most austere desert or apparently featureless moor is a dense, intricate network of thousands of species of photosynthesizers, predators, prey animals, parasites, detritovores and decomposers. As naturalist E. O. Wilson put it: “A lifetime can be spent in a Magellanic voyage around the trunk of a single tree.” And not all of what one might learn from such a voyage would be transferable to the next tree. History, chance, climate, geology and — increasingly — human fiddling mean that no two ecosystems work in the same way.

Scientists like to impose structure and order on chaos, and ecologists are no different. Ecology has its grand theories, but they are riddled with conditional clauses, caveats and exceptions. There are clear patterns at the global and single-species scales, but the middle ground is, as biologist John Lawton affectionately put it in 1999, "a mess". It is doubtful that the generalities that underlie the complex patterns of nature will ever be phrased succinctly enough to fit on a T-shirt.

This complexity is demonstrated by work that questions a famous and elegant 'trophic cascade' in Yellowstone National Park, Wyoming, discussed on page 158. The theory goes that wolves, restored to the park in the 1990s after decades of absence, scare elk away from certain areas. That has a knock-on effect for the rest of the food chain, allowing aspen and willows to flourish after decades of being browsed nearly to death. But studies in recent years suggest that wolves alone do not control the ecosystem. Other factors — the presence of beaver dams and grizzly bears, weather, hunting by humans and even climate change — also affect the elk population and the growth of trees and shrubs.

It would be useful to have broad patterns and commonalities in ecology. To know how ecosystems will respond to climate change, or to be able to predict the consequences of introducing or reintroducing a species, would make conservation more effective and efficient. But a unified theory of everything is not the only way to gain insight.

More ecologists should embrace the non-predictive side of their science. Teasing out what is going on in complex systems by looking at how ecosystems evolved, and by manipulating the environment in experiments, is just as much a science as creating formulae for how ecosystems work.

Paradigm shifts, after all, are rare in ecology. Debates are often resolved when competing concepts combine, rather than when one pushes the other completely off the table. Take the contrasting ideas of top-down regulation of ecosystems by carnivores and bottom-up regulation effected by the nutrition available from plants. The field is slowly working towards an integrated theory to predict when the top will rule and when the bottom will be in charge — and that theory will take the time to consider the middle players, the herbivores.

Other ecological debates have followed a similar path. Disagreement over whether complex ecosystems are more or less stable than simpler ones, for example, is also settling to a consensus: it depends.

Useful practical predictions need not stem from universal laws. They may come instead from a deep knowledge of the unique workings of each ecosystem — knowledge gained from observation and analysis.

> ***"If ecosystems all worked in the same way, they would lose much of their mystery, their surprise and their beauty."***

Proposing sweeping theories is exciting, but if ecologists want to produce work useful to conservation, they might do better to spend their days sitting quietly in ecosystems with waterproof notebooks and hand lenses, writing everything down.

Ecological complexity, which may seem like an impenetrable thicket of nuance, is also the source of much of our pleasure in nature. If ecosystems were simple puzzles that all worked in the same way, they would lose much of their mystery, their surprise and their beauty. A lot of conservation work aims to protect the complexity and variability that makes ecosystems so hard to understand, and indeed to conserve.

Ecological rules are not the only reasons to promote conservation and fight extinctions. Sometimes we can argue for the conservation of particular species because ecology provides a scientific basis for it. At other times, we make the argument because there is a good chance that ecology will soon catch up and explain why the species are important.

But even if some predators do little but sit at the top of their food pyramids, creaming off a few herbivores, would we really want to live in a world without them? Answering that question really is easy. ■

Share alike

Research communities need to agree on standard etiquette for data-sharing.

Every mountaineer knows the sinking feeling of reaching a peak after a hard climb, only to see the true summit still above. Scientists who take on the tough terrain of open access may have a similar experience. After they reach the notable goal of sharing their research papers, they discover that a higher summit awaits: open data.

In many fields, making research data available online for all is a step beyond making research papers open-access. This might puzzle communities that have already agreed to share. Biologists routinely upload DNA sequences to the public repository GenBank, for example, creating a scientific commons for everyone's benefit. There are now more than 600 subject-specific repositories, with community-specific standards.

Yet even some of the most strident open-access supporters baulk at the concept of fully open data, judging by the reaction to a strengthened data-sharing policy instituted by the Public Library of Science (PLOS) this month. PLOS now requires researchers to make their papers' underlying data open online on publication, apart from data that they have a duty to keep private, such as that on human study participants (go.nature.com/rd27aa). Journals such as *Molecular Ecology* have mandated the same thing for years. But the PLOS move has provoked heated discussion and highlighted some important, yet unsettled, aspects of the practice and ethics of online data-sharing.

A few years ago, a survey found that scientists cited a lack of time and money, as well as technical barriers, to explain why they did not post data online (C. Tenopir *et al. PLoS ONE* **6,** e21101; 2011). It still takes time to prepare data, but increasingly, other excuses do not fly. General-purpose storage sites such as Dryad and figshare are cheap (or free) and suitable for all kinds of data sets; data journals provide publication venues appealing to the traditionally minded; and standards are emerging for citing other people's data sets (see *Nature* **500,** 243–245; 2013).

Harder to surmount are the feeling of data ownership and the fear of being 'scooped'. Years of toil to collect a data set that might support a decade of career-making publications could be rendered moot when another researcher jumps on the information online. This is a particular problem for early-career researchers, and for those working with unique data sets in small ecology or environmental-science laboratories.

Behind this fear is the worry that other scientists will not provide credit for the data they use. Research administrators place such importance on paper authorship that it is probably not enough for a study that leans significantly on another researcher's hard-won data set to merely cite that researcher, perhaps depriving them of a publication.

Communities need to debate the ethics of data-sharing and agree on etiquette. When a researcher relies on another's data, for example, it should be standard practice to invite the data-providers to be co-authors. Ecologists Clifford Duke and John Porter have suggested guidelines for deciding whether to extend such an invitation (C. S. Duke and J. H. Porter *BioScience* **63,** 483–489; 2013); these include noting whether the data are integral to the new analysis, whether the data are unique or particularly novel, and whether the data-provider can fully participate in manuscript-writing by approving draft and final versions. Another ecologist, Dominique Roche, has urged disclosure of data reuse, and better communication between data generators and reusers (D. G. Roche *et al. PLoS Biol.* **12,** e1001779; 2014).

It is not clear whether widespread online data-sharing will increase uncredited scooping. For now, *Nature* mandates uploading data when structured community data repositories exist, and encourages it otherwise. Before you can climb the highest mountains, you need proper safeguards and a decent map. ■

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